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ABSTRACT

This publication contains energy education activities for grades 4 through 12 and is part of a set of three publications. These activities are organized under five energy concepts: (1) energy is so basic that nothing moves without it; (2) conservation of energy; (3) there are other energy alternatives; (4) society depends on energy; and (5) the production and distribution of energy have environmental and economic consequences. This publication is constructed in a looseleaf fashion to facilitate the reproduction of activities. Grade level, objective, materials, and a description are given for each activity. The variety of activities include laboratory experiments, values clarification exercises, simulations, games, and independent student investigations. Activities are included that may be used in one or more subject areas so that an interdisciplinary approach to energy education is achieved. (MR)

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OKLAHOMA

ENERGY AWARENESS EDUCATION
Grades 4-12

Oklahoma State Department of Education
Leslie Fisher, State Superintendent of Public Instruction
1977

SE 024 109

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CHAPTER XII

ENERGY EDUCATION ACTIVITIES
Grades 4-12

BASIC CONCEPTS FOR ENERGY STUDY

1. Energy is so basic that nothing moves or is accomplished without it.

2. Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

3. Presently, most of our energy requirements are met through using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal, which must be considered and developed.

4. Energy, its production, use, and conservation, are essential in the maintenance of our society as we know it.

5. The production and distribution of energy have environmental and economic consequences.

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modified from Mengel, Wayne. Energy: Key to the Future, Dutchess County Board of Cooperative Educational Services, Poughkeepsie, New York, 1974, ED 092 395.

DOING WORK

Grade Level 7-10

Purpose: To demonstrate the definition of energy as the ability to do work.

Concept: Energy is required to lift objects. The amount of work done (or energy used) can be measured.

Activity:

A. Materials--

Spring Scale
Inclined Plane (could be a book and a meter stick)
1 length of string (about 1.5 meters)
1 Paper Clip formed into a hook
1 Meter Stick
1 Toy (car, truck, bus, skate--a toy with wheels which roll)

Procedure--

Attach the toy to your spring scale and lift it slowly to a height of 0.5 meter (50 centimeters) above the floor. Record the force-measurer (scale) reading under Lifting Force in the table below

Direct Lift

Distance Lifted (meters)	Lifting Force (grams)
0.5	

Now you're ready to lift the cart with an inclined plane. Place a meter stick next to the upper end of the plane. Make a small pencil mark at the spot where it rests on the pegboard. This spot is 50 centimeters (0.5 meter) above the floor.

Set the cart on the incline with its rear wheels at the bottom. Use your spring scale to pull the cart smoothly up until the rear wheels pass the 0.5 meter mark you

---

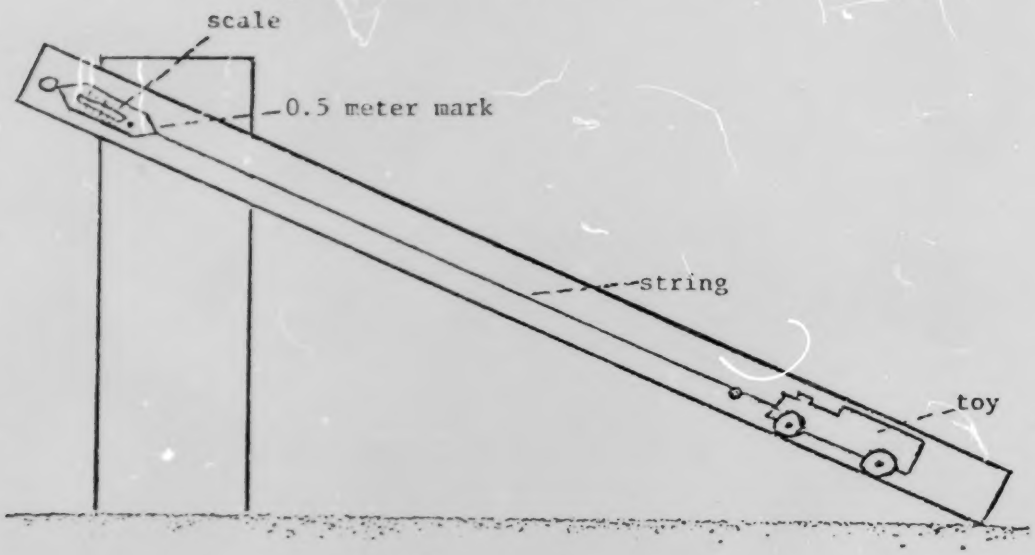
ISCS, Level 1, Probing the Natural World, Silver Burdett, Ch. 5.

made. Be sure the string points straight along the plane as you pull. Practice until you can keep the force-measurer reading fairly steady as you pull. Pull the cart smoothly up the plane until the rear wheels pass the 0.5 meter mark. As you pull, watch the spring scale and record this pulling force. The distance pulled is how far the cart traveled along the plane. Record the distance pulled and the distance lifted.

Inclined Plane

Pulling Force (grams)	Distance Pulled (meters)	Distance Lifted (meters)
_____	_____	0.5 meter

Question: Which took more work (energy), lifting the cart with the inclined plane or lifting it directly?



WORK

Grade Level 7-10

Purpose: To show that the same amount of work is done no matter what method is used to raise an object.

Concept: The sun is the basic source of all energy. We get our energy from food and almost half of all our energy resources are used to produce, process, and deliver our foods.

Activity:

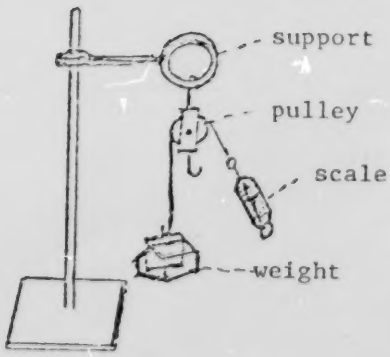
A. Materials--

1. Pulleys (double and single)
2. Spring Scale
3. String
4. Ring stand or other support
5. Object to lift
6. Meter Stick

B. Procedure--

1. Allow the students to see how many different ways they can assemble a pulley or series of pulleys in order to lift a weight.

2. Once they have tried several different methods (movable, fixed, single, double, etc.) stop them and have them try the following.



Weigh the weight being used and try the various methods of lifting the weight using the pulleys. Measure the following: (1) force needed on the string to lift the weight; (2) the distance the string is pulled in order to raise the weight 15 centimeters.

Point out that the amount of work done (the force times the distance the string was pulled) will be equal no matter which method is used to lift the weight 15 centimeters.

FOOD AND ENERGY

Grade Level 4-10

Purpose: To give the student an awareness of the major areas of energy usage.

Concept: Food is a source of energy and its production requires large amounts of other energy sources, mainly fossil fuels.

Activity:

A. Materials--

Blackboard or overhead projector

B. Procedure--

Ask Students:

1. Why do our bodies need food?

2. What is the major energy source used to produce food?

3. What else, besides the sun, is necessary to produce food?

4. Let's trace the making of a hamburger bun from the planting of the wheat seeds to the eating of the bun.

5. Let's see if we can find what other kinds of energy is needed to produce food and at what points and how often it is needed.

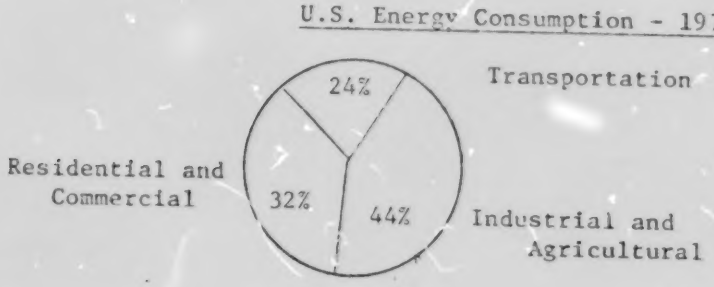
6. Help students generate a diagram similar to the one on the next page; or let small groups of students create a part of the total and order it all, marking in red each time a fossil fuel is used.

7. We find fossil fuels, namely gas and oil, used in ____ places. Of all the fossil fuels we have, how much do you suppose is used for transportation? for residential and commercial ____? for industry and agriculture ____? If we add transportation, industry and agriculture how much of our available energy is used directly or indirectly to make our food? (See U.S. Energy Consumption--1972 Graph on the next page.)

Beyond the Rhetoric, Energy Information, Cities Service Company, P.O. Box 300, Tulsa, Oklahoma 74102 (Book and slides, $3.00), Graph, page 9.

1. Almost all the energy in the world comes from the sun.
2. Plants use sun's energy plus soil plus water plus air to grow.
3. Plant seeds require rich soil to grow. We add fertilizer (made from fossil fuel to enrich the soil).
4. Soil must be plowed with tractors--these require fossil fuels. Metals used to make tractors require energy in their manufacture.
5. Food (from the field, wheat [grain] must be hauled to the elevator or mill). This requires more trucks, more gas and oil.
6. At the mill, cleaning and grinding the wheat into flour requires energy. It is packaged and then;
7. The flour is transported to the distributor (more gas, oil, metals are required).
8. The distributor sells the flour to the bakery.
9. The truck unloads the flour and the hamburger buns are made. All the other products had to be hauled in also.
10. The buns are delivered to the supermarket; where,
11. Your Mom buys it and hauls it home; where,
12. Mom makes you a hamburger.
13. To give you energy for work and play.

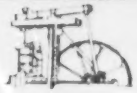
U.S. Energy Consumption--1972 Graph



Finish the Energy Timeline

cut

1780 1785 1790 1795



1776
In England James Watt puts two engines to work in factories & starts an energy revolution. The energy is _____

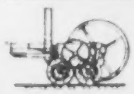
1783
Two men fly in a balloon at _____. The energy used is _____

Most people burn wood for heating and cooking and travel by horse or on foot.

1800
In Italy, _____ invents the battery and gives his name to the volt. The energy produced is _____

cut

1800 1805 1810 1815 1820 1825



1804
An Englishman, Richard _____ puts James Watt's engine on wheels and rails. He is the father of the railroad locomotive.

1807
Robert Fulton doesn't build the very first _____, but he makes the one people first pay to ride on.

Wood continues to supply most household energy needs. But coal begins to do more in factories and railroad engines.

1821
First attempt to develop and market natural gas near Fredonia, N.Y.

cut

1830 1835 1840 1845

1829 An American named _____ and an Englishman named _____ each invents a generator. Who is first? _____ The energy produced? _____

1837 Americans put new inventions to work. First comes McCormick's _____, then the steam shovel by _____, and the telegraph by _____

Railroads expand rapidly, hauling freight and passengers brave enough to stand the jolts and to risk hot cinders that often fly from the engine into their cars. England is first and America second in railroad locomotive production.

cut

1850 1855 1860 1865 1870 1875

1859
Edwin Drake strikes oil in Pennsylvania beginning the _____ industry.

1860
Lenoir of France invents the _____ combustion engine.

An explosion inside a cylinder paves the way for the later invention of the automobile. An oil strike hastens the discovery of the fuel that will run it.

cut

Source: The Energy Challenge, FEA

cut

1880 1885 1890 1895

Coal and wood still furnish most of the energy in homes. "Iron horses" and real ones continue to take most people places. Although the electric bulb has been invented most people still use kerosene or gaslights to read by.

1884
In England, Charles Parsons perfects the steam _____ and advances the development of electrical energy.

1885
Karl _____ builds the 1st successful automobile.

1892
The oil burning engine is invented by _____. Eventually, this engine will replace steam-powered ones.

1895
The power of Niagara Fall is harnessed to make _____

cut

1900 1905 1910 1915 1920 1925

1903
The engine in the Wright brothers' plane is powered by _____

1905 Albert Einstein develops a theory for measuring energy and prepares the way for the _____ age.

1910
Ford makes the first Model _____ car.

By the end of this period, many new homes have coal furnaces in the basement. And more and more cars appear in garages.

cut

1930 1935 1940 1945

1926
Robert Goddard tests a _____

1936
Hoover Dam on the Colorado River is built to generate _____ power.

1940
_____, a fiber made from oil, coal, and water makes its first public appearance.

1942
In Chicago, Enrico Fermi sets off the first _____ chain reaction.

Many homes convert from coal to natural gas for heating. Most families own at least one car and some have two.

cut

1950 1955 1960 1965 1970 1975

1952
Bell scientists raise hope for our energy future with the _____ battery.

1957
The U.S. gets its first big _____ electric power plant at Shippingport, Pa.

Demands for energy grow. America gets more people, more homes, more factories and businesses, more cars, more trucks, more buses, more planes. Demand grows faster than supply.

1970
Congress passes the _____ Air Act.

1973
OPEC nations _____ oil and produce an energy crisis.

1976 Americans continue to look for ways to _____ the energy we have and find new sources.

cut

Source: The Energy Challenge, FEA

Finish the Energy Timeline

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In England James Watt puts two engines to work in factories & starts an energy revolution. The energy is steam

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Two men fly in a balloon at Paris, France. The energy used is hot air

Most people burn wood for heating and cooking and travel by horse or on foot.

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In Italy, Volta invents the battery and gives his name to the volt. The energy produced is electricity

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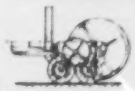

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The power of Niagara Falls is harnessed to make electricity

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Hoover Dam on the Colorado River is built to generate hydroelectric power

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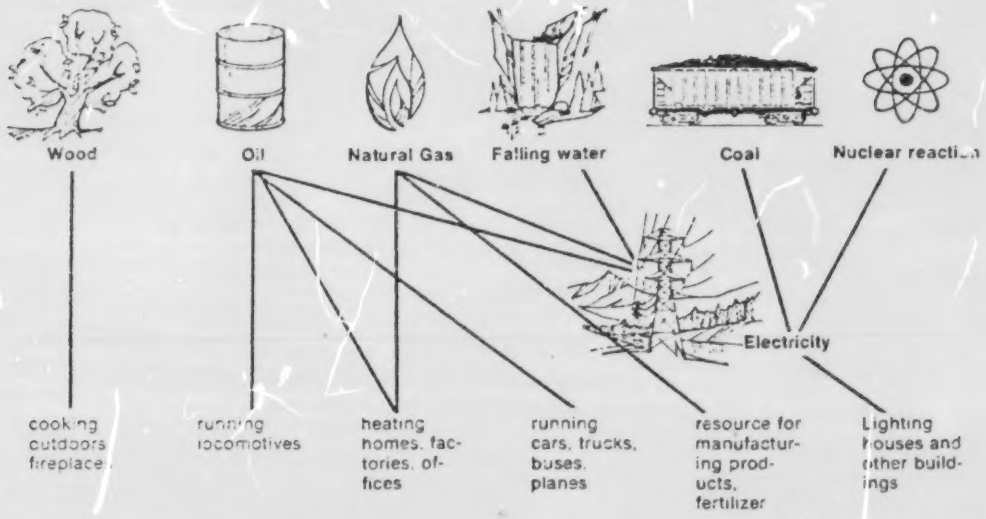
cut

Source: The Energy Challenge, FEA

Primary Energy Sources



The diagram above shows six *primary sources* of energy. Lines connect each primary energy source to the most important work it does. Which energy source is seldom used today? Which two do not involve burning to produce power? Which ones are used to make electricity?

Use the information on the chart and on the energy timeline to help you complete these four stories about the Spritz family.

1. In 1907 Great-grandma and Great-grandpa Spritz went by train to Niagara Falls for their honeymoon. The train engine burned _____ _____ to boil the water that made the _____ _____ that drove it. The *primary* source of energy was _____ _____. Not long ago their great-grandchildren flew by jet to California. The primary energy source that got them there was _____.

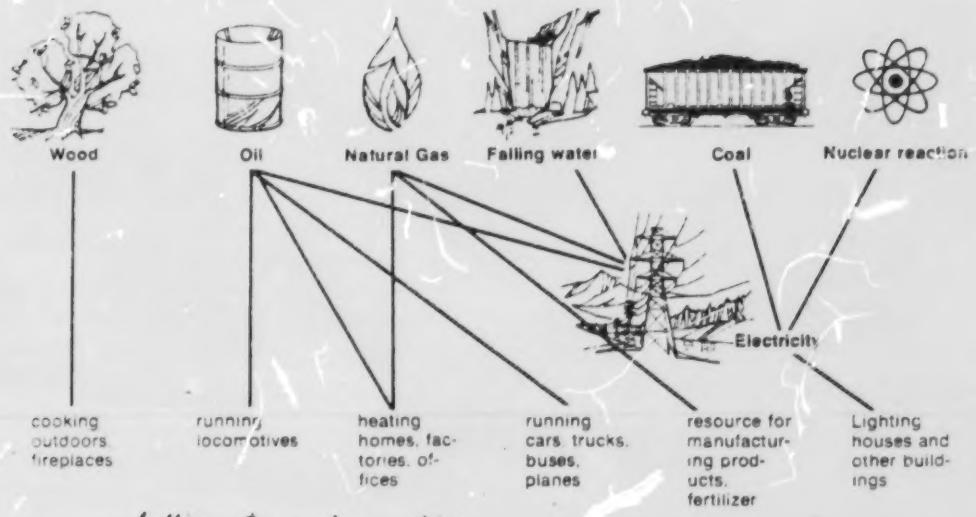
2. Great-grandpa Spritz was one of the first in town to drive an automobile. His Model T burned _____ _____. The primary source of this fuel is _____. A Spritz great-grandson earns his living driving a big diesel truck. The primary source of this fuel is _____.

3. Four generations of Spritzes have lived in the old family home. At the turn of the century, the family huddled around a stove in the parlor for warmth. Probably the primary energy source was _____ _____ _____. In 1928 the family put in central heating by installing a furnace in the basement. The primary energy source was _____. Since 1952 the Spritzes, like most Americans, have heated their homes with a primary energy source that is clean and convenient to use. It is _____ _____.

4. Recently a young Spritz asked how the electricity that lights the house and runs the appliances is made. His dad drew a picture of a giant wheel with blades. "This is a _____ engine," he said. "There are a number of these at our city's power plant. These giant wheels turn to make electric energy. Falling _____ or powerful blasts of _____ turn the wheels. You can't get steam, of course, without boiling water. And so a primary energy source furnishes heat to boil the water." The primary energy source that makes most of our electricity is coal. Other sources might be _____ or _____ _____ or _____.

Source: The Energy Challenge, FEA

Primary Energy Sources



falling water, nuclear reaction

The diagram above shows six *primary sources* of energy. Lines connect each primary energy source to the most important work it does. Which energy source is seldom used today? Which two do not involve burning to produce power? Which ones are used to make electricity? wood, oil, natural gas, water, coal; nuclear

Use the information on the chart and on the energy timeline to help you complete these four stories about the Spritz family.

1. In 1901, Great-grandma and Great-grandpa Spritz went by train to Niagara Falls for their honeymoon. The train engine burned coal to boil the water that made the steam that drove it. The *primary* source of energy was coal. Not long ago their great-grandchildren flew by jet to California. The primary energy source that got them there was oil.

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3. Four generations of Spritzes have lived in the old family home. At the turn of the century, the family huddled around a stove in the parlor for warmth. Probably the primary energy source was coal or wood. In 1929 the family put in central heating by installing a furnace in the basement. The primary energy source was coal. Since 1952 the Spritzes, like most Americans, have heated their homes with a primary energy source that is clean and convenient to use. It is natural gas.

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Source: The Energy Challenge, FEA

THE GOOD OLD DAYS?

Interview someone who is old enough to remember what life was like before the days of great usage of oil and natural gas. Ask him or her the questions that follow and others that you think of yourself.

1. What kind of lights did you use in your home?_____
   _____How was it heated?_____
2. What fabrics were clothes made of? Was clothing harder or easier to take care of?_____
3. What sort of washing machine did you have?_____
4. What kind of stove (and what kind of fuel) did you family use for cooking?_____
5. Did you have a refrigerator? How did you keep your food fresh?
   _____
6. How was food packaged when it came from the store?_____
   _____What did milk come in?_____
   Was your milk delivered?_____How?_____
7. What sort of soap did you use? Did it clean as well as the cleaners we have now?_____
8. How was your water heated for bathing and laundry?_____
   _____
9. Did your family have a car?_____If not, how did you travel?
   How did you get to school?_____
10. Did you have a radio? What did it look like?_____
    _____Did you go to the movies?_____
11. What kinds of entertainment did you enjoy?_____
    _____

(Think up as many more questions of your own as you can. Ask them during the interview. Put the answers on the back of this paper.)

To close the interview, ask these questions and write the answers on the back of this paper.

In what ways is life for you more enjoyable now that we have electricity, plastics, detergents, and other oil and natural gas products?

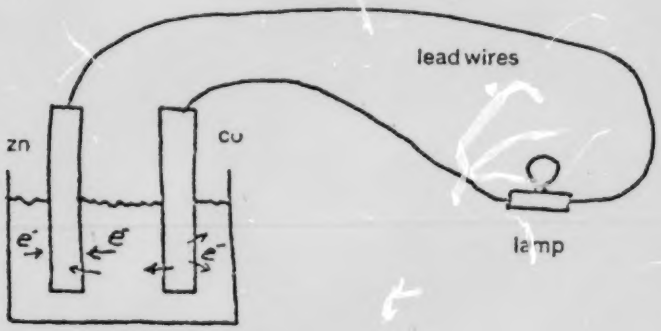
In what ways did you like the "good old days" better?

TRANSFORMING CHEMICAL ENERGY TO ELECTRICAL ENERGY

Grade Level 7-12

Objective: To demonstrate the energy found in a chemical reaction.

Materials: Sulfuric acid or electrolyte solution, zinc strip, copper strip, low voltage lamp, beaker, two lead wires.



Background:

1. Electrolyte solution--a substance which dissociates in the solvent to form charged particles or ions.
2. Zinc strip becomes negative pole, zinc ions leave the strip which causes a negative pole.
3. Copper strip becomes positive pole, hydrogen gas forms at the copper strip, this gas formation removes electrons (-) from the copper strip which causes a positive pole.
4. Batteries and dry cells work the same way, but use different materials. Students may be assigned to research and report to class how a battery and dry cell operate.

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

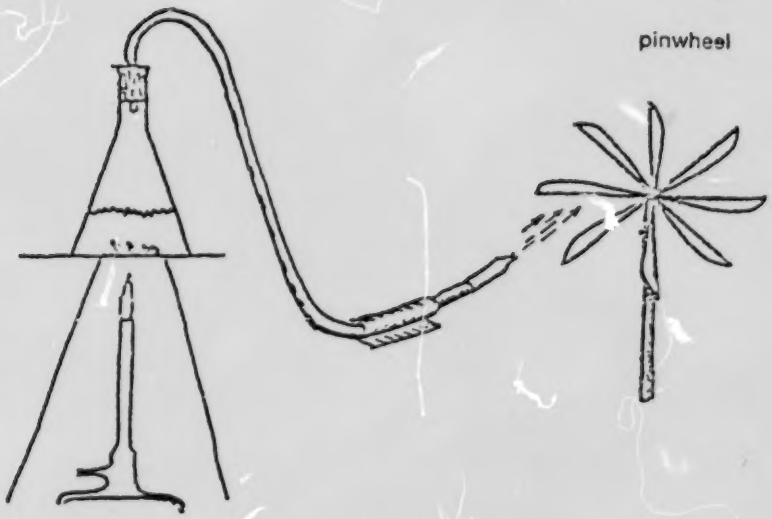
TRANSFORMING CHEMICAL ENERGY TO MECHANICAL ENERGY-- THE TURBINE

Grade Level 4-10

Objective: To demonstrate to the student how the burning of fuels can be used to turn electric generators and how steam turbines operate.

Activity: Fill a 250 ml. pyrex flask with about 100 ml. of water. Fit the flask with a one-hole rubber stopper. Attach a glass jet tip from a medicine dropper to the other end. Heat the water slowly to boiling. Enough steam should be generated to spin a pinwheel, simulating the action of turbines used to operate electrical generators.

CAUTION: Do not heat the flask too rapidly! If you produce steam faster than it can escape through the tube something will give! Be sure to add boiling chips to water! Insulate the part of the rubber tubing you are holding with a paper towel.



Energy Activities for the Classroom, West Virginia Department of Education, 1975.

PRODUCING STATIC ELECTRICITY

Grade Level 4-9

Objective: To give the student a better understanding of static electricity and how it can be produced.

Activity:

A. Rub a hard rubber rod or comb with a piece of wool. Hold one end of the rod near small bits of paper. Describe the results.

B. Rub a glass rod with a piece of silk. Hold the rod near the same small bits of paper as you did with the comb. Describe the result.

C. Blow up a balloon. Rub the balloon against your hair. Try sticking the balloon to the wall.

D. Home Activity: If you have a shirt or blouse made of nylon or orlon put it on and go into a darkened room. When your eyes have adjusted to the darkness stand in front of a mirror and take the shirt off. Watch it in the mirror. Describe the results. Shake the shirt. What happened?

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

PRODUCING CURRENT ELECTRICITY

Grade Level 4-9

Objective: To give the student a better understanding of current electricity and how it can be produced.

Activity:

I. By Chemical Methods

A. Cut two slits an inch in length in the skin of a lemon. Push a strip of copper into one and a strip of zinc into the other (a penny and a zinc coated washer can be used to replace the copper and zinc strips). Connect a wire from the copper strip to the (+) terminal of a galvanometer and a wire from the zinc strip to the (-) terminal. Watch the meter. Describe the results.

B. Connect a carbon rod to the (+) terminal of a galvanometer by means of a copper wire. Connect a zinc strip to the (-) terminal of the galvanometer as you did with the carbon rod. Place both the carbon rod and the zinc strip into a strong solution of ammonium chloride (NH_4Cl). Watch the galvanometer.

C. Repeat Activity B using the carbon rod and the zinc strip in a dilute solution of hydrochloric acid (HCL). Observe the meter. Is the voltmeter reading different from what it was in Activity B?

II. By Mechanical Methods

A. Take some fine insulated copper wire and wind about fifty to one hundred turns of it around a hollow tube such as a mailing tube or the center of a roll of tin foil. Connect the ends of this wire to the two posts of a galvanometer. Push one end of a bar magnet through the center of the coil of wire. Observe the galvanometer. Now pull the magnet out of the coil and observe the galvanometer again. Describe any differences that you might observe.

B. Obtain a small model generator. Observe the parts of the generator. In what ways is the generator like the device in Activity A? Turn the handle of the generator slowly. Observe the bulb. Now turn the handle faster. Describe any differences that you observe.

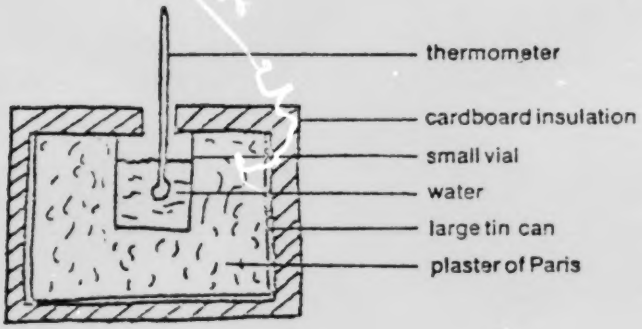
Energy Activities for the Classroom, West Virginia Department of Education, 1975.

TRANSFORMING CHEMICAL ENERGY TO RADIANT (HEAT) ENERGY

Grade Level 6-9

Objective: Chemical energy may be transformed to radiant (heat) energy.

Material: Large tin can, small vial or test tube, thermometer, plaster of Paris



Activity: Mix the plaster of Paris and pour it in the large tin can. Immediately place the vial containing water and thermometer into the semi-liquid plaster of Paris. Record the temperature at the beginning of the activity and a final reading when the plaster of Paris has hardened. Discuss the range of temperature change.

Advanced Work:

1. Use a measured weight of water and calculate calories of energy released. Calories = change in temperature in ^{o}C. (x) water weight in grams.

2. Alter the amount of plaster of Paris and graph curves of change in: amount of plaster vs. temperature change.

3. Alter the mixing directions of plaster, which will alter concentration; graph and discuss results.

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

TRANSFORMING MECHANICAL ENERGY TO RADIANT (HEAT) ENERGY

Grade Level 4-6

Objective: To demonstrate that mechanical energy can be changed to another form (in this case, heat energy).

Materials: Quarter-inch wood dowel, knife, hand drill, wooden block

Activity: Mechanical energy is the energy produced when objects, like machines, are moving. A moving automobile, a turning windmill, or a rolling wheel all produce mechanical energy. Mechanical energy can be changed into other forms very easily. You can observe this in the activity below. Sharpen a quarter-inch dowel to a point. Fasten the blunt end in a hand drill. Cut a small pit in a wooden block for the pointed end of the dowel to fit loosely. Have another student hold the block and turn the crank of the drill rapidly. What form of energy is produced when you turn the crank? After a few minutes feel the end of the dowel and the pits in the wooden block (carefully). What form of energy do you feel?

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

GETTING TO THE NUCLEUS OF THE MATTER

Grade Level 4-12

Objective: To give the student practical experience with nuclear energy and discuss nuclear power.

Activity:

A. SPINTHARISCOPE--grades 4-8

A spinthariscope is a simple device for observing the emission of particles from a radioactive source. It can be as simple as observing a radium-dial watch under a microscope or a magnifier in a completely dark room to observe the small flashes when the radiation leaves the radium and strikes the surface coating of zinc sulfide. It also can be made by making a light-tight box with a lens in the lid. The inside of the box could be painted black. Place the watch in the bottom of the box.

Read about nuclear energy. What causes the flashes? What is emitted from the radium?

B. CLOUD CHAMBER--Secondary

In the cloud chamber one supercools the air so that a vapor trail will form along any passing particle. In this way students may view the trails of sub-microscopic sub-atomic particles.

The chamber may be constructed by taking a large wide-mouth jar and gluing dark absorbent material (velvet; blotter paper) across the bottom and around the sides. Leave an opening about 5 cm across in the covering on the bottom to allow for viewing and a pair of similar openings on opposite sides near the top for illumination. Use clay to support a radioactive source (luminous watch part) up from the inverted lid.

Pour about 5 mm of alcohol (duplicating fluid) into the jar thoroughly soaking the absorbent material and then seal the jar. Place the inverted jar on dry ice. (Caution: dry ice is extremely cold and will damage the skin on contact.) By placing your hand on the bottom of the inverted jar you should create sufficient heat to vaporize some of the alcohol. In about 15 minutes you should see tiny cloud tracks near the source if you shine a light across this area.

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

Describe the cloud tracks and the directions they take. Read in a science text about radioactive materials and their emissions. What causes the cloud tracks? What types of particles are emitted from the radium?

C. Have students research nuclear energy, stressing the following areas:

1. Diagramming and discussing nuclear power plants, including fuel, shielding material, moderators, dampers, coolant, turbine, generator and heat exchange.

2. Comparison of nuclear energy to other types (for example, 1 kg. of coal burns in 3.6 seconds in a power plant to produce 10 kwh of energy, and 1 kg of uranium fissions in 2½ weeks in a power plant to produce 22,000,000 kwh of energy).

3. Advantages and disadvantages of nuclear fission plants. Include the fact that 6 percent of electrical power plants today are nuclear fission and 60 percent of those on order are nuclear. Discuss the prime difficulties with fission plants--that of radioactive wastes and thermal pollution of water. It has been estimated that by 1983 "fail-safe" nuclear power generators will be possible. The types of reactors should be discussed (boiling-water reactor, pressurized-water reactor, high-temperature gas-cooled reactor, and the breeder reactors). The types of fuels (uranium, thorium, and plutonium, etc.) could be discussed, as well as types of coolant.

4. Nuclear fusion as opposed to fission plants should be discussed, even though fusion plants probably will not be practical until the end of the century. Fusion plants have the advantage of an almost unlimited source of fuel (deuterium, obtainable from the ocean) and no radioactive waste problem. The difficulty is the problem of containing the huge amounts of heat released (up to 50 million degrees).

5. Discuss the use of radioactive materials in medicine.

DESTRUCTIVE DISTILLATION OF COAL

Grade Level 6-9

Objective: To test whether or not NH_3 and H_2S are present in soft coal and to determine whether coal or coke would be best for burning in a fireplace.

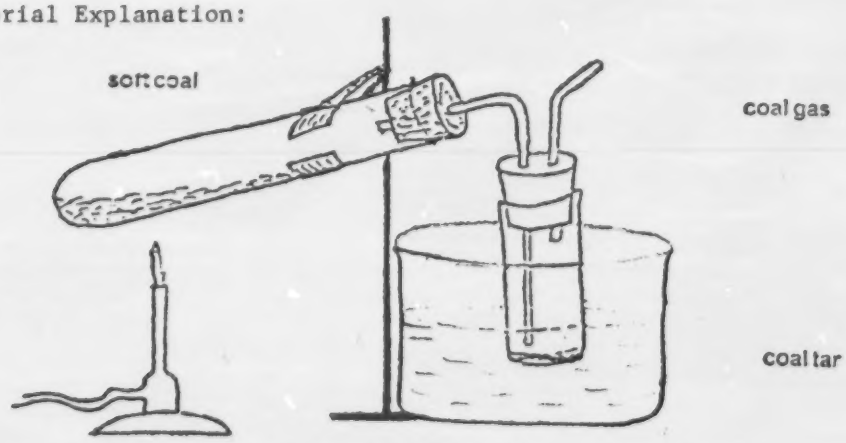
Materials: Bunsen burner, glass or plastic container (quart capacity), 2 stoppers (1-1 hole, 1-2 holes), 2 glass tubes or pipettes (1 curved 8" and 1 straight 3"), 1 test tube holder, soft coal, water, matches, and red litmus paper.

Activity: Set up the apparatus in a well-ventilated part of the classroom or outdoors. Fill the distillation tube one-third full with pieces of soft coal, and heat the tube. Test the gas coming from the nozzle to determine if it burns. Test this gas for hydrogen sulfide (H_2S). Hold moistened lead acetate paper in test gas. If the paper turns black, H_2S is present. Some types of coal give off large amounts of ammonia (NH_3) during destructive distillation. Test for this gas by holding a wet piece of red litmus paper in the escaping gas. If NH_3 is present, it will turn moistened red litmus blue.

Continue heating the coal until all the gases are driven off, then examine the material remaining in the tube. How does this substance, called coke, differ from a piece of soft coal the same size?

Burn coke and soft coal (separately). Which produced a better fire? Which material would be better for use in a fire place?

Pictorial Explanation:



CAUTION: This investigation should only be done in a well ventilated room.

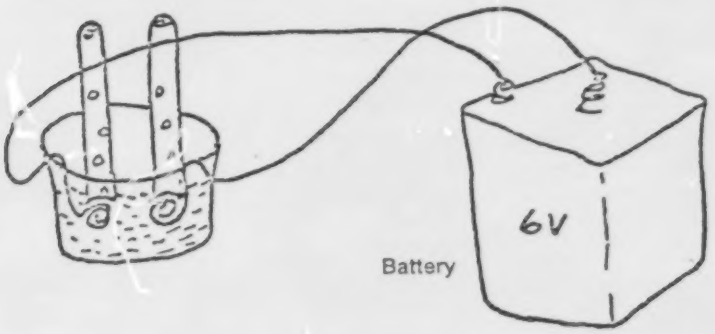
Energy Activities for the Classroom, West Virginia Department of Education, 1975.

A GAS AS A FUEL

Grade Level 5-9

Objective: To demonstrate that hydrogen may be used as a fuel

Activity: Invert two test tubes filled with water and place in a large plastic dish nearly filled with water. Small clips to hold the test tubes are necessary. Prepare a sodium sulfate solution by dissolving 5 level teaspoonfuls into 200 ml of water in a beaker. Pour about 30 ml of this solution into the plastic dish. Now connect a 6 volt battery to the clips on the dish by means of alligator clips. Bubbles should be observed in the water and should collect in the test tubes.



The tube with the most gas collected contains hydrogen. We have used electricity to break water apart into hydrogen and oxygen. When the tube is almost filled, unhook the battery, put your thumb over the ends of the test tube containing the hydrogen while it is under water, then take the tube out of the water and turn it upright. Be sure to keep your thumb over the end or cork it to keep the hydrogen from escaping.

Now light a match and hold it near the mouth of the test tube and release the hydrogen. The "pop" you hear is the reaction of the flame with hydrogen. This harmless "explosion" is the test for hydrogen.

Would hydrogen be a good fuel? What are its advantages and disadvantages? It has been mentioned that hydrogen may be a possible source of fuel for automobiles. What problems are associated with it? Look up the dirigible "Hindenberg".

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

Extended Activities:

1. Research natural gas: how it is formed in the earth, how it is obtained from the earth, how it is transported to users, and how it is consumed. Diagram a natural gas well. How is natural gas stored? Where are the known reserves? Are we in danger of running out? What percentage of consumption in the U.S. is natural gas?

2. Methane is a gas which composes a large part of natural gas. It has also been used as a fuel. How? It has been mentioned as a possible replacement for gasoline. Research this. A unique method of production of methane is collection of methane gas from animal manure or sewage. Is this practical? What are the problems?

ENERGY GRAB-BAG

Grade Level 4-12

Objective: To discuss different energy sources

Activity: Students will work in groups of 3-5 students. Each group will be provided with a grab-bag which will contain items representing an energy source. The students will take out the items one by one and discuss what type of energy source it may represent.

Examples of items which may be in the bag are:

Aluminum foil (reflect solar energy)
Picture of a geyser (geothermal)
An article of trash (burning garbage)
Battery (electrical)
Shale oil from oil-bearing shale)
Child's twirly bird (windmills)
A Card with an H on it (Hydrogen)
Model of an atom (nuclear)

Discussion may also involve classifying the energy sources, such as mechanical, electrical, chemical, radiant or nuclear. This can be adapted for different grade levels.

This lesson would also be very effective as a learning center with a tape recorder.

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

SQUEEZING OIL FROM A ROCK

Grade Level 4-12

Objective: To promote a discussion on shale oil

Materials: Baking soda, salt, sand, rocks, iron filings, sugar, water, shale, several beakers

Activity: Present the students with several mixtures. Tell them what is in each one except the shale. Have a discussion on how one would separate each of the mixtures. After the methods of separation have been exhausted, present the following problem: suppose this rock had a liquid in it, such as oil; how would you go about separating it from the rock. Discuss the students' hypothesis. The teacher will then discuss shale oil and its value as a potential energy source.

Background: High grade oil shale contains enough oil to equal the known crude oil reserves in the world. If low grade deposits were used it could last, at present consumption, one hundred and fifty years.

Oil shale is neither oil or shale, but a limestone-like sedimentary rock. It has high fossil content.

Shale oil has a very low sulfur content; which is a major problem in petroleum and coal; but, shale oil has high nitrogen content which causes problems in refining.

The oil shale is refined by crushing the stone and heating it; a vapor is given off. The vapor is condensed and gas and oil are collected. The largest problem is that the "shale" increases in volume after burning. What do you do with extra rock?

It is estimated that by 1986 large scale shale oil recovery will be possible.

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

FOSSIL FUEL TIME LINE

Grade Level 6-12

Objective: To demonstrate the process and span of time necessary from the formation of fossil fuels (coal, oil, gas) to their use.

Activity: Have students research the time involved and the processes from the formation of fossil fuels to the consumer. The students may work in groups on the following topics:

1. How did the fossil fuels get into the ground? How were they formed? What period of time was necessary for their formation? What period of time in the history of the earth did this occur? In what areas of the earth were they formed? Are fossil fuels being formed today?

2. When and how were each of the fossil fuels first discovered? How were they obtained from the earth when they were first discovered? How were they used when they were first discovered? Many local utility offices have excellent resource materials.

3. Have groups of students research the methods by which coal, oil and gas are obtained from the earth. What period of time is required from the time of discovery of fossil fuels to when they can be brought to the surface?

4. How are the fossil fuels refined and transported to the consumer? What types of transportation is used? What types of energy are consumed in this refining and transportation? How much energy is consumed in the refining and transportation processes?

5. Groups of students may be assigned to report on how these fuels, particularly oil and gas, are converted to heat within the home.

Students may make a time line showing the relative amounts of time from original formation to consumption. Murals or diagrams could be made to describe the entire process from formation to consumption.

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

Extended Activities:

1. What are renewable resources? Are fossil fuels renewable resources? Have students research types of renewable resources; in particular, wood and water. Use tree farming to discuss the values, methods and problems involved in maintaining renewable resources.

2. Have students discuss the characteristics of the "perfect fuel". Some characteristics are: Unlimited, equal distribution throughout the world, no technical problems of obtaining and transporting to the consumer, highly efficient, no aesthetic problems, no adverse effects on the environment, no conversion losses during use.

3. Discuss uses for energy hydrocarbons other than just to be burned as a fuel. Ex. plastics, dyes, medicines, etc.

TOPOGRAPHICAL MAPS

Grade Level 10-12

Purpose: To predict the location of coal beds from topographical maps.

Concept: Presently, most of our energy requirements are met through using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

Reference: Activity suggested by Wayne R. Flint, Science Teacher, Streetsboro High School, Streetsboro, Ohio.

Activity: Many minerals such as coal and limestone occur in distinct layers called beds. These beds usually cover many square kilometers (sq. mi.) and usually are tilted or bent downward in one direction. Once strip mining has started at several points on a single bed of mineral, it is easy to plot the outline of the bed and predict its mass and volume from a topographical map.

1. Have student teams make a topographical cross section of an area which has several strip mines scattered across it. This is accomplished by drawing a straight line across a topographical map then plotting on graph paper each of the contour lines that touch the straight line.

2. Have the students mark on the completed cross sectional plots the locations of each strip mine that touches the line drawn on the map. Since coal (and other minerals) occur in beds, the students can sketch the location of the hidden coal bed by connecting the elevations of the strip-mined areas.

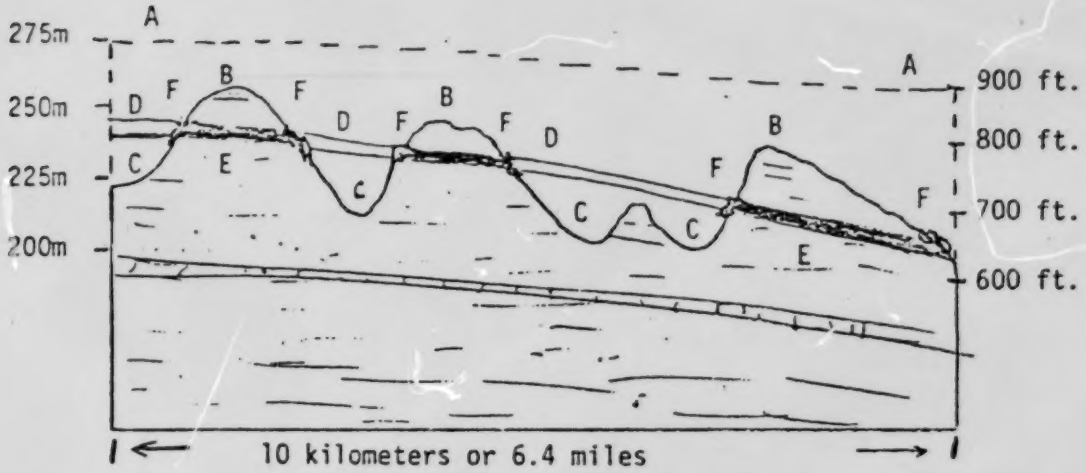
3. The amount of tilt (dip or strike) in the bed can be readily determined by examination of the graphed data.

4. If the mined area is located close to the school, the approximate volume of coal present in the bed can be estimated. Measure the bed's thickness at road cuts and on the mine high walls. Next, multiply the surface area of the bed times its thickness times the specific gravity of the coal.

Energy Activities for the Classroom, ERIC/SMEAC.

Teaching Notes: The teacher must check the map carefully in advance of this exercise to make sure only one mineral is being strip mined in the map area being studied. Otherwise the students will usually unknowingly plot both mine systems on one paper and get a set of data they cannot interpret.

The finished cross sectional diagram should be similar to the one shown below.



Legend:
A--Land surface before erosion started
B--Present hilltops
C--Present valleys
D--Coal bed removed by erosion
E--Remaining coal bed
F--Strip mined areas

WHICH IS BEST FOR MY COMMUNITY?

Grade Level 6-12

Purpose: To practice group decision-making skills

Materials: Energy Source Summary Chart

Advance Preparation: Make copies of Energy Summary Chart for distribution to entire class. Present students with the opportunity to determine, through their roles as citizens of a totally new community, how they might change their community if they could start anew. Have students discuss whether some of our energy-environment problems might be solved by new community designs. In particular, have students examine and research possible sources of energy for heating and cooling homes and offices of their new community.

Arrange desks in a circle to facilitate discussion. Meet with Chairperson and Secretary and review the agenda and use of the summary chart.

Activity:

1. Begin meeting by establishing the procedures.

Have Chairperson call meeting to order and post a chart listing the agenda for the meeting. Be sure to include the order of group presentations. Have the Secretary pass out the Energy Summary Chart (change to headings conforming with group's criteria) and briefly explain how it can be used for note taking. For example, the students may jot figures, examples, notes, pluses (+) or minuses (-), etc., in the appropriate columns. They should record whatever they feel will help them compare the advantages and disadvantages of the sources of energy and be prepared to make a decision on the source of their choice.

2. Have groups give reports.

Set a time limit for each, such as three minutes. Allow a brief question period at the end of each presentation.

3. Review and discuss reports.

After the last committee report, allow the students to review their notes and have a brief general discussion of the energy sources. Encourage discussion of advantages and disadvantages of each energy source. Group may wish to identify which is best in terms of

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NSTA, Energy-Environment Mini-Unit Guide, pp. 112-113.

other uses, costs, lifespan, environmental effects etc. Allow time for each person to think about his decision.

4. Allow students to vote on their preferred source.

Students may use hand vote or secret ballot for voting. Students will select their preferred source of energy for heating and cooling homes.

5. Guide evaluation of the decision.

Announce the results. The group may want to rank its second and third choice also. Briefly discuss the decision made. Ask:

a. What influenced your decision most? (Listen to several responses.)

b. What are the advantages and disadvantages of the source of energy chosen? (Have students refer to notes on summary chart.)

c. What does this decision indicate about the factors that are important to us as a group? (Is cost important? Availability? Environmental effects?) What were we willing to trade off?

d. Why can't a real community decide as we have? What problems does it face that we have not considered?

(Possible considerations:

__ All sources of energy are not equally available to all communities.

__ Homes and businesses already have some source of heat and cooling which would have to be converted if a change was made. This change would be costly.

__ Some sources of energy need improved technology before they can be useful for large communities.)

Have students compare their original choice (on the first day) with their individual final choice and the group's choice. Did their choice change as a result of new information?

6. Have students review the process they have used in making this decision.

Focus attention on the decision-making process that has been used in this mini-unit. Ask such questions as:

a. What was the problem that we wished to resolve in this unit? (Define the problem.)

b. What method did we use to solve the problem? (Divided into groups, did research, gathered information, established factual base for decision making.) Why did we divide into seven groups? (We identified seven alternative choices.)

c. How did the group reach its decision? (Held meetings, shared information, summarized, discussed, voted.)

d. How did we evaluate our decision? (Reviewed advantages and disadvantages of chosen source, inferred our priorities from such a choice, related choice to practical limitations which exist in real communities.)

After this review, students may want to record the steps of the decision-making process:

a. Define the problem.

b. Plan a method for investigating the problem. Identify alternative choices.

c. Gather and evaluate information.

d. Decide and act.

e. Evaluate the decision made.

7. (Optional) Have students compare their choice for their new model community with the sources used in their present community. What are the trade-offs in their present community?

ENERGY SOURCE SUMMARY CHART

Energy Source / Factor	Availability		Cost	Environmental Effects		
	Now	Later				
1. Oil						
2. Natural Gas						
3. Coal						
4. Electricity						
5. Nuclear						
6. Solar						
7. Geothermal						

HOW ENERGETIC IS YOUR COMMUNITY?

Grade Level 6-12

Objective: To make students aware of local energy resources, consumption and problems.

Activity:

A. Local Business

1. Divide students into a number of small groups and assign each group certain businesses within the community. Suggested sites for study are grocery stores, service stations, restaurants, clothing stores, etc.

2. Have each group arrange a field trip to their assigned business and an interview with an appropriate person at the site where possible to discuss what measures are currently being taken to conserve energy. Students should be aware of the type of business and what sources of energy they use.

   Types of things to look for are: type of lighting used, fuel used for heating and production (if it is industry), type of heating used and any other kind of energy consumption. Students should also observe potential sources of wastefulness, such as doors and windows left open, lights left on in areas not in use, too high or too low a temperature maintained, uses made of hot water, type of insulation used, etc.

3. Students should report their findings to the class, along with a discussion of possibilities for energy conservation. A report should also be made to the manager of the business. NOTE: Caution students--small businesses often cannot take advantage of modern saving technology.

B. Local industries, power companies, etc.

   Students should be aware of all major energy consumers and producers within the local community. Have them study the local industries, their sources of energy, the types of fuel used, what type of energy is involved in each step of the process, and possible pollution. A field trip should be arranged as well as an opportunity to speak to a representative of the industry to discuss

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Energy Activities for the Classroom, West Virginia Department of Education, 1975.

the types of energy consumed or produced and steps taken by the industry to conserve energy.

C. Transportation

Have students inventory local traffic patterns by stationing them at particular points during particular times of the day, and have them gather information such as number of vehicles passing that point, types of vehicles (whether car, truck, station wagon, taxi, bus, etc.), whether commercial or domestic, number of passengers, size of vehicle, etc. They may also survey to find the approximate number of cars in the community, average number and type per family, number of commercial vehicles operating within the community, etc.

The students will be interested in time and places of heaviest traffic, ratio of cars to trucks, parking facilities, pollution, traffic jams, public transportation facilities and use, available railway systems, etc.

D. Problem solving

Assign students or groups of students to current local problems or hypothetical problems related to their own community. Help to define the problem, identify the needs, set a hypothesis, identify a projected budget for solving the problem, as well as personnel needed, and a way to evaluate whether the hypothesis will work.

Local problems may be related to energy waste by local businesses or industries, pollution, lack of public transportation, public apathy toward carpooling, utility rate hikes, etc.

Hypothetical problems may be: setting up a gas rationing system, cutting the number of autos in town by one-half, cutting the amount of energy used by local businesses by one-half, establishing an ideal transportation system, setting up a car pool system in their community, etc. Some of the officials in Washington feel that a 20 percent reduction is not too difficult.

STUDENT SURVEYS

Grade Level 4-12

Purpose:

1. To find if the demands being made of the public to successfully deal with the present energy crisis are in opposition to the desires and aspirations of the general public.

2. To find if the average citizen views the energy crisis and responds to it only as he or she is affected. If there a lack of national consciousness for the total problem?

Activity:

A. Have students survey their friends, business people, and leaders in the community concerning their desires, needs, and aspirations as they see them. Have class discuss these findings to see if they are consistent with the existing needs of society to deal effectively with the energy crisis.

   1. Do they plan to buy a new automobile in the near future? Why or why not? What are the qualities they are looking for in a vehicle? What is their use for the vehicle?

   2. What appliances do they plan to purchase? Do they feel these appliances are necessary? What appliances do they have in the home that they consider important to their life style? We are interested in type of appliance--refrigerator (self defrosting?), television (colored? second set?), air conditioners, etc.

   3. What are their vacation plans for the year?

   4. What do they consider a comfortable temperature in the home? (During the winter, summer?) Do they attempt to maintain this temperature?

   5. How much driving do they do each month? Where do they drive? (Consider all members of the family.) Do they participate in car pools or use public transportation?

   6. Do they have an automatic washer and dryer? How often do they use these appliances?

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

B. The students should ask the people being interviewed a series of questions concerning the use of energy which would provide for possible conclusions indicating how they view the energy crisis.

1. Have you reduced the amount of gasoline for driving purposes? Why or why not?

2. Do you turn off lights in the house when they are not needed? Why or why not?

3. Have you lowered the temperature in your home? (When going to bed? When away? All of the time?) Why or why not?

4. Have you attempted to reduce the amount of hot water used?

5. Do you think there is a fuel shortage? Why or why not?

6. Do you feel utility bills are reasonable? Why or why not?

7. Do you drive at the legal 55 m.p.h. speed limit?

C. After compiling, presenting, and discussing the findings, attempt to draw some conclusions concerning the type of information and approach needed to arouse the public awareness of the problem being considered.

1. This information will be most useful if we can understand the point of view from which the public views the situation. Role playing would be a means of establishing the point of view of those whose behavior is in opposition to conservation and those who are convinced of the need for conservation.

2. Class should consider type of approach they feel will be most effective from the information accumulated. Would "lecturing" or authority approach be useful? Would logical reasoning be successful? Would an appeal to humanitarian interest be successful?

Suggestion: A tape recorder may be used very effectively here.

INSULATION

Grade Level 4-3

Purpose: To determine which material is a better insulator and to gain insight into conservation of energy through use of insulation materials.

Concept: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

Reference: Activity suggested by Erma Lewis, Elementary Teacher, Columbus, Ohio.

Activity: Have children bring in fruit juice cans and insulating material or use materials from a classroom "resource box".

Introduce by asking: What is insulation? Which materials are better insulators? List on chalkboard in order of insulating properties as chosen by the class. What would happen if a can were painted black?

Divide the class into groups of 3 or 4. Each group obtain a fruit juice can and insulating materials, if any, they will use.

Group 1: No insulating material

Group 2: Paint outside of can black

Group 3: Styrofoam packaging material, measure thickness

Group 4: Newspapers, same thickness as styrofoam

Additional groups choose other insulating materials same thickness as styrofoam such as cloth, fiberglass, insulating materials from a local contractor, plastic.

Each group prepare their juice cans. Place an ice cube in each can. Place all cans either in the sun or in the shade. Check the ice cubes at fifteen minute intervals until the first ice cube is melted. Continue to check until all ice cubes are melted. Record the time it takes to melt each ice cube.

Discussion: How did the black paint affect the insulating qualities of the can? Which material served as the best insulator? The poorest? List in order of insulating properties.

Compare with original list. How can this knowledge be used to conserve our energy supplies? Should builders be required to insulate homes? Stores? Factories? Ask each student to check how their own homes are insulated.

Note: The following page contains information which should be helpful with this activity.

R-VALUES, U-VALUES, AND HEAT LOSS

The "R-value" is a measure of the resistance of a material to heat flow. The higher the R-values, the less heat will flow. Here are some typical R-values:

1/2 inch gypsumboard	0.45 R-value
1/2 inch plywood	0.62
common brick, per inch thickness	0.20
1/2 inch insulated board sheathing	1.32
linoleum, vinyl, or rubber floor tile	0.05
carpet and fibrous pad	2.08
carpet and foam rubber pad	1.23
3/8 inch built-up roof	0.33
air space 1-4 inches	1.00
2-2 1/2 inches insulation	7.00
3-4 inches insulation	11.00
5-7 inches insulation	19.00

The net insulation provided by several materials is calculated by adding the R-values together. For example, consider an exterior wall:

Wall Construction	Uninsulated Wall Resistance	Insulated Wall Resistance
3 inch common brick	0.6	0.6
1/2 inch insulated board	1.32	1.32
3-1/2 inch air space	1.0	0.0
3-1/2 inch insulation	0.0	11.0
1/2 inch gypsumboard	.45	.45
	3.37	13.37

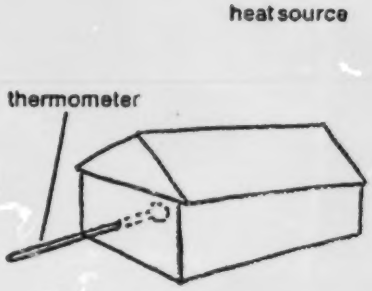
Heat loss is calculated by converting the R-factor into the U-factor (U=1/R). Units have been set so that heat flow (BTU's per hour per square foot) result from multiplying the U-factor by the temperature difference (^{o}F) between inside and outside.

HOUSE DESIGN AND ITS EFFECT ON ENERGY CONSUMPTION

Grade Level 6-12

Objective: To show that house design and building materials effect the loss or gain of energy.

Activity: The student will design and construct different styles of buildings and test them for energy efficiency. The building could be built from popsicle sticks, covered with different materials, painted different colors, and show different architecture, i.e., ranch, two-level. The buildings could be tested for efficiency by placing a thermometer in the structure and testing for heat transfer. Results could then be discussed.



Possibilities for variation are volumes, surface areas, paints, slants of roofs, wood vs. metal walls, effect of wind on different structures, glass vs. solid walls, etc.

Extended Activities:

1. To assess the effect that color has on heat absorption and reflection, place 1-hole rubber stoppers in 6 test tubes. Place a thermometer in each test tube. Behind each tube place a different sheet of colored paper (black, blue, red, white, green, foil). Record the temperature of each. Place in the sun and check the temperature after 5 minutes. Continue for 30 minutes. What have you discovered?

   Repeat the experiment, but this time wrap each test tube completely with the paper. Take an initial reading, and a reading after 30 minutes. Is there any difference between this and the first experiment? Explain any difference.

   Further questions might include: What colors would you want your house if you lived in Arizona? in Alaska? What shade roofing shingles?

   You might extend the experiment to include clothing--what color clothing should you wear in summer? winter?

Energy Activities for the Classroom, West Virginia Department of Education.

2. Students may be asked to bring in building supply advertisements that are currently promoting added insulation, thermal pane windows, use of wood (why?).

3. Students may involve themselves in a class contest to design their own house, which would be constructed in order to save the maximum amount of energy. Variations might include number of windows, exposure of windows, slant of roof, use of landscaping and trees for breaking wind, types of heating system, interior design and materials, etc. Investigate the use of solar energy to heat and cool the home.

FAMILY CAR

Grade Level 4-6

Purpose: To determine fuel efficiency of students' family cars.

Concept: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

Activity:

1. Plan with the class to get parental cooperation in determining miles per gallon obtained by family cars during a common period of time such as Saturday morning to Saturday morning (one week). Plan, if possible, for children to accompany parents to the gasoline station and record initial mileage, gallons needed to fill the tank the second time, and final mileage. Ask students (with parental help if needed) to calculate miles per gallon.

   When data is brought to class the following Monday organize it into a matrix under headings such as sub-compact, compact, full size, station-wagon and/or other categories deemed appropriate (such as engine size or vehicle weight).

   What kinds of cars were most efficient? Why? Was this a good experiment? How could it have been improved? Whose father or mother gets the best mileage? The worst? Why? Is it a good idea for the EPA to report to the public the results of their mileage tests on new cars? What kind of car will pupils buy when they get old enough?

2. A. Keep a log of all trips made with automobile for two weeks.

   B. Separate list into those which could have been eliminated by using the telephone, those which were within walking distance, those which would have been very difficult to walk, and those which were impossible to walk.

   C. For a two-week period can you cut down on the trips within walking distance?

   D. How much gasoline was used in the two-week period? Calculate the number of gallons, the cost per gallon and the total cost of fuel.

E. Combine lists for the classroom.

F. Outline the advantages of walking short distances rather than driving (energy conservation, parking, risk of accident, pollution, exercise, social aspects, environmental appreciation, economy, etc.). List the disadvantages (time consuming, inconvenient, small children at home, etc.).

G. Do the same for various means of public transportation.

TRANSPORTATION

Grade Level 6-12

Purpose: To examine energy usage in various modes of transportation.

Concept: Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

Reference: A Teacher's Handbook on Energy, Colorado Department of Education, Denver, Colorado 80203

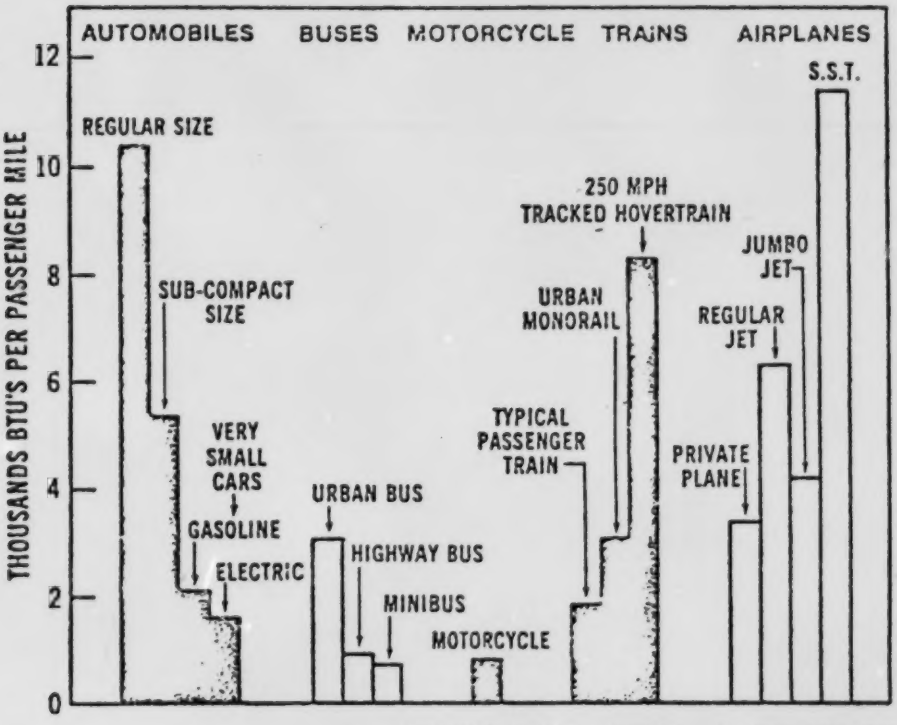
Activity: Present to the class the graphed data shown on the next page "Transportation Energy Consumption of Various Modes".

Divide the class into four groups entitled (1) automobiles, (2) buses, (3) trains, and (4) airplanes. Assign each group the responsibility to examine carefully the data concerning the efficiency of various vehicles within their mode of transportation. Each group should also compare the efficiency of their mode with the other three.

Each group should select a spokesman or two who will explain, as clearly as possible, why certain vehicles in their types of transportation are more energy consumptive than others. The spokesman should also report and defend the group decision as to whether "their type" of transportation should increase or decrease in the years ahead.

ERIC/SMEAC, Energy Activities for the Classroom.

TRANSPORTATION ENERGY CONSUMPTION OF VARIOUS MODES



	MODE	PASSENGER MILES PER GALLON	NUMBER PASSENGERS	THOUSANDS BTU'S PER PASSENGER MILE
Autos:	Regular Size	12	1.3	10.4
	Sub-compact	23	1.3	5.4
	Very Small (gasoline)	59	1.3	2.1
	Very Small (electric)	78	1.3	1.6
*Buses:	Urban bus	40	12	3.1
	Highway bus	140	22	0.9
	Minibus	175	7	0.7
*Motorcycle:	(2 HP)	160	1	0.8
*Trains:	Passenger train	65	300	1.9
	250 mph Tracked Hovertrain	15	48	8.3
	Urban Monorail	40	20	3.1
*Planes:	Private plane	37	3	3.4
	Regular jet (DC-8)	20	80	6.3
	Jumbo jet (B-747)	30	200	4.2
	S.S.T. (Mach 2.7, U.S.)	11	150	11.4

*Source: *Rice, Richard A., 1972, "Energy Efficiencies of the Transport Systems;" a paper presented before the Society of Automotive Engineers at the International Automotive Engineering Congress, Detroit, Michigan, January, 1973.*

MASS TRANSIT

Grade Level 6-12

Purpose: To examine the role of mass transit in fuel conservation.

Concept: Energy production, use, and conservation are essential in the maintenance of our society as we know it.

Reference: Ris, Thomas F., Editor. Energy and Man's Environment: Elementary Through Secondary Interdisciplinary Activity Guide, Education/Research Systems, Inc., 2121 Fifth Avenue, Seattle, Washington 98121.

Activity: Discuss with students the types of public transportation or mass transit systems available to U.S. cities (bus, subway, train). It has been suggested that through greater use of these, private citizens would use less fuel.

Suppose this were put into action.

List the fuels that would be saved. What, if any, new fuels would be used?

What jobs might be lost?

What new jobs would be created for these new transportation systems?

Economically, would it be beneficial to adopt a mass transit system in place of the present auto-dominated one?

Conservationally, would there be a sufficient reduction in fuel usage and pollution to warrant this change-over?

ERIC/SMEAC, Energy Activities for the Classroom.

KEEP IT COOL

Grade Level 4-12

Purpose: To identify the direction of heat flow

Materials:
- ice cubes
- Ziploc bags
- milk cartons
- foil
- string
- cardboard
- Transparency 1 and 2 (Teacher make transparency from original)
- styrofoam
- paper
- wood
- metal cans
- glass container

Activity: Part I: Save that Ice Cube!

By participating in a game to preserve an ice cube, students become aware of the capabilities of different materials to insulate. This lesson should be performed early in the day, since ice cubes may take about two hours to melt.

1. Introduce game and organize teams

   As a suggested lead-in, tell students that you have collected some materials together for an interesting game that everyone can play. Inform them that you have a bag of ice cubes, enough to give one ice cube to every two or three students. The goal of the game is to prevent the ice cube from melting for the longest time possible--they must keep it cool!

   Divide the class into groups of two or three persons. Display the materials (see materials list) that can be used by students to wrap or enclose ice cubes to preserve them. Ask each group to propose ways to do this and to perhaps write down their best idea. Encourage groups to choose different materials and means of construction, such as thickness of wrapping.

2. Proceed with game

   When all groups have proposed a plan to preserve their ice cubes, let them proceed with their plans. Give each group an ice cube (they should be nearly equivalent in size) in a small plastic sandwich bag taped shut (this will keep the water from the melted cubes confined) or use Ziploc bags.

   You may find students wrapping their ice cubes in paper or foil or burying them in some material where

they will not be visible. Therefore, in order to keep track of the melting process place one ice cube in a plastic bag and suspend it by a string someplace in the classroom where it will be visible to the students (not in the sunlight near a window). This ice cube will be used as a timer: when it is almost completely melted the game will end. It will take about one and three-quarters hours for a typical ice cube from a refrigerator tray to melt. However, this lesson can effectively end when all groups have finished wrapping their ice cube and the timing begins. You may want to go on to some other unrelated classroom activity during the period while the ice cubes are melting. Occasionally, have students check the ice cube that is serving as the timer to see if it is completely melted.

3. Conclude the game

When the ice cube suspended in the plastic bag is melted or nearly melted, have students obtain the ice cube bags from their environments and compare the results. Identify with students the materials which preserved the ice cube the longest. Did the thickness of the material make any difference? Ask them to think about what materials they would use if they played the game again.

Ask students to save milk cartons for Part 3.

Part II: Insulation and Heat Flow

Students develop concepts of insulation and heat energy transfer (or heat flow) through classroom discussion.

1. Lead students to the concept of heat energy transfer.

Review results of game. How long did it take for the unwrapped ice cube to melt? Were any ice cubes still unmelted? Which materials preserved the ice cube the most at the end of the game and what materials were used to preserve it?

Ask students: "Why did the ice cubes melt?"

Provide clues to answer: "Would you say the ice cube is cold? Is the room warmer than the ice cube?"

Inform students that one of the laws of nature is that warm things have more heat energy than cold things, and when a warm thing is placed near or around a cold thing, some of that heat energy is transferred or flows to the cold thing. By wrapping

or enclosing the ice cube, students were slowing down the transfer of some of the heat energy in the room to the ice cube. The results of the game indicate that some materials can slow down the transfer of heat energy more than others.

2. Develop with students a definition of insulator.

   Ask: "Which materials did we find slowed down the transfer of the heat toward the ice cube more than others? Can we give these materials a name that tells us they are good materials to slow down the motion of heat? Let's call them insulation materials or insulators."

   Discuss with students what materials might be called good insulators and what materials might be called poor insulators. Have students classify materials they used in game as good or poor insulators based on the results of their game.

3. Generalize experience by providing other examples of heat energy transfer and insulation.

   Discuss with students several examples in which insulation is used to keep things cold; for example, ask students:

   a) "Can you think of other situations where we try to keep things cold by using insulation? How about a refrigerator? Where is it cold? Where is it warm?" (Draw a sketch or display a picture of a refrigerator.) "Which area has more heat energy? Which has less? How is the transfer of the heat slowed down?"

   b) "Suppose you bought some ice cream at the supermarket to take home. Is the ice cream put in a special bag to prevent it from melting? Where is it warm, where is it cold? What kinds of materials are used to slow down the transfer of the heat energy to the cold area?"

   Discuss with students several examples in which insulation is used to keep things warm; for example:

   Ask students:

   a) "Do you wear heavier clothes (coats, etc.) in the winter than you do in the summer? Why? Is it colder? What kinds of clothes does an Eskimo wear? A Hawaiian? Could we call the clothes an

Eskimo wears insulators? Which area has more heat energy? Which less energy? Can clothes slow down the transfer of heat energy from one area to another?"

b) "Are there other examples you can think of where we use insulation to keep things warm? That is, examples where we slow down the transfer of heat and try to prevent it from leaving something so it will stay hot? How about coffee cups? How are they made? Are good or poor insulators used?"

4. Relate discussion to home insulation in preparation for next lesson.

Ask students:

"Are the walls and ceilings of our houses or apartments insulators? Why? What happens in winter? Where is it cold? Where is it warm? In what direction is the heat transferred?" (Inside to outside) "Is it slowed down in any way?"

"What happens in summer? Suppose you have an air-conditioner. Where is it cool? Where is it hot?" (Cool is inside, hot outside) "In what direction is heat transferred?" (Outside to inside) "Is it slowed down in any way?"

As an assignment, ask students to investigate at home the kinds of materials that are used to keep things cold or hot. Perhaps they can arrange with their parents to view some area in their house or building where the insulation is exposed, such as in an attic. What kinds of materials are sold in hardware stores and lumber yards to insulate homes?

Request that students think about how they would insulate a house--what materials they would use and where they would put them, and how these would slow down the transfer of the heat energy.

Remind students to bring in milk cartons for tomorrow's lesson.

Part III: Insulation and Homes

The relationship between the increased use of insulation in homes and the decreased use of electricity and the cost for cooling and heating homes is developed.

Special preparation: Collect milk cartons

1. Review assignments with students. Discuss with students their examples of situations where insulators are used to keep something hot or cold, and of how their homes are insulated.

2. Organize and proceed with second "Keep It Cool!" game with model houses.

   Conduct same type of game as in first lesson, except this time have students construct small model houses using pint or one-half pint milk or cream containers (see drawing on page 135). Have students "insulate" house by wrapping or gluing different materials on outside of container. Have students place ice cube in plastic bag inside container. Time game as before with a separate ice cube which is uninsulated.

3. After game has started, discuss with students the role of an air conditioner.

   "How many students have an air conditioner in their homes? Have you been in stores or other places with air conditioners? Is it colder inside or outside?" Ask students if they know what powers most air-conditioners.

   "What would happen if they were unplugged? What do the air conditioners obtain through the wires from the plug to the unit?"

   Bring out the point that most air conditioners run on electricity. "What would happen if there was a power failure and they didn't work? Would the rooms warm up and 'melt?' Could the air be kept cold for a longer period of time if there were more insulation? Would it be as necessary to run the air conditioner for as long a time if a house or store had more insulation? If we use an air conditioner less, is less electricity used?"

4. Compare insulated and uninsulated homes.

   Show Transparency 1 and ask students to describe the differences between the two homes in the summer. Which one has more insulation? Which one is cooler? Hotter? Which one is using more electricity?

   Tell students that we must pay for the electricity we use, usually each month, when the bill from the electric power company comes in the mail. Ask them:

"Which house used more electricity and thus would cost more to keep cool with air conditioning?"

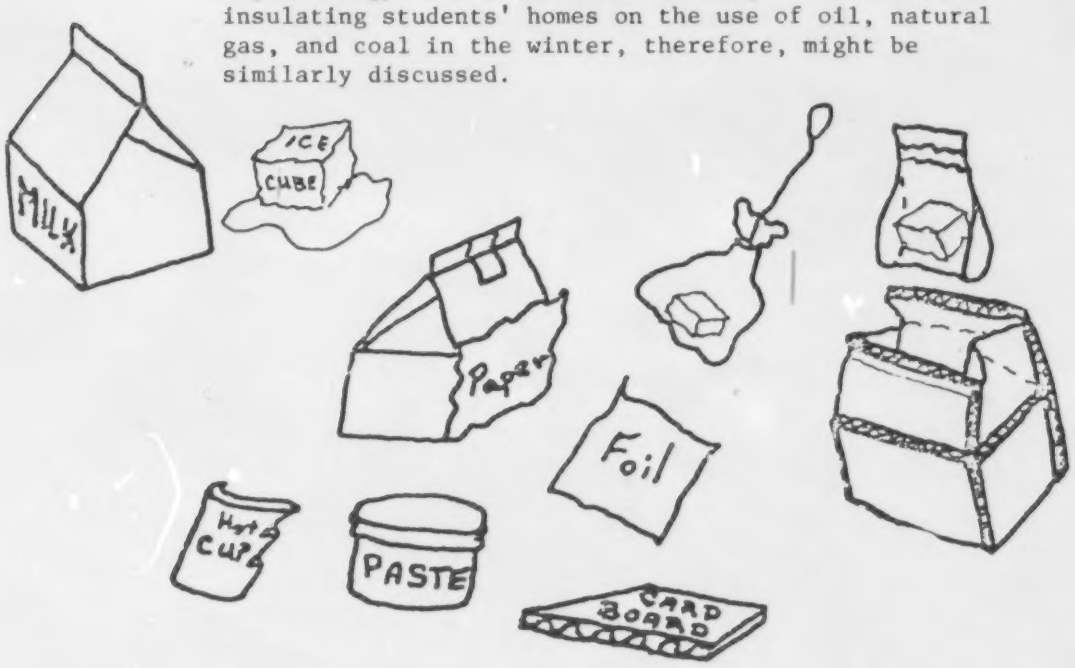
Inform them that in an average size house each year they could save $35 to $60 or more if the house had adequate insulation in the ceiling and walls.

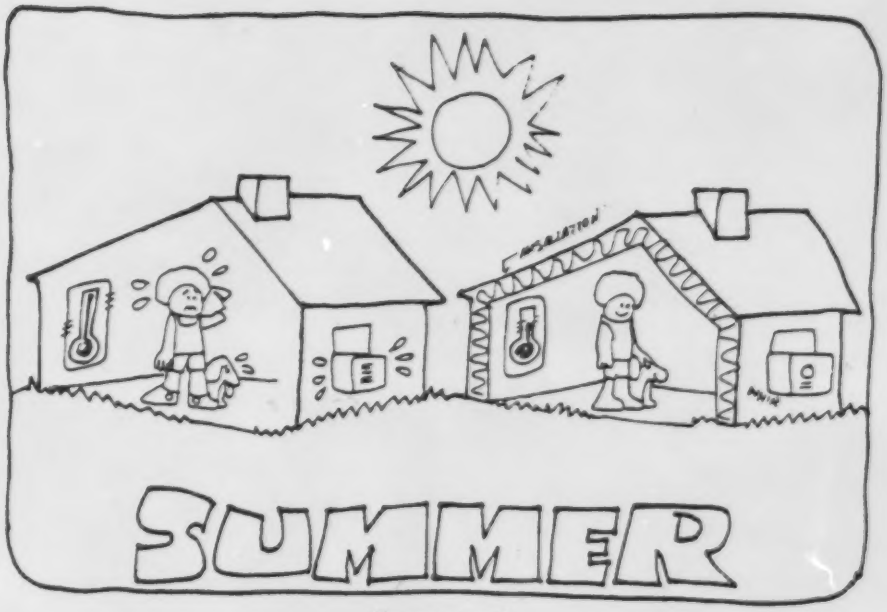
Ask students to describe the differences between the two homes shown in Transparency 2 in the winter. Which one has more insulation? Which is warmer? Colder? Which one would use more electricity or some other fuel to keep the house warm? Inform students that each year a family could save $425 to $712 by having an insulated house compared to an uninsulated house.

5. Have students choose their preferred home. Conclude discussion by asking students to choose the home they would rather live in and to describe their reasons. Proceed to other classroom activities if ice cubes still have not melted.

6. Conclude mini-unit at conclusion of game. When uninsulated ice cube has melted, have students remove their ice cubes from their model houses. Determine which houses preserved the ice cubes the best. Discuss the results with students.

7. (Optional) Electricity is the major energy source for home air conditioning; however, it is not the major energy source for home heating. The effect of insulating students' homes on the use of oil, natural gas, and coal in the winter, therefore, might be similarly discussed.





Transparency 1

Transparency 2

WHERE WE GET OUR ENERGY
HOW WE USE IT

Graph A divides our energy use into four groups. In what group do we use the most energy?_____

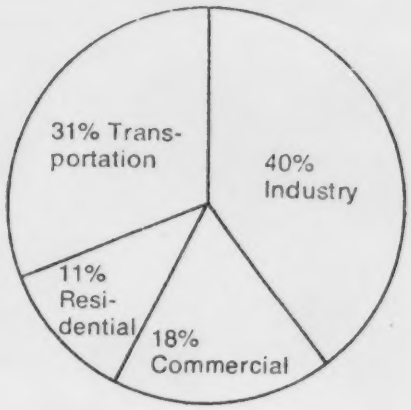
_____

What ranks second?_____

_____ In what ways do you use energy in each of these two groups? What group(s) gives you the most opportunity to cut down on your energy consumption?

Which groups use energy when you do each of the following. Check the box or boxes in the appropriate columns. (The first one is done for you.)

Graph A



	Industry	Transportation	Commercial	Residential
1. Take a hot bath				✓
2. Drive to a hamburger stand				
3. Fly in an airplane				
4. Switch on air conditioning				
5. Buy a new baseball				
6. Ride a school bus				
7. Blow dry your hair at home				
8. Buy a frozen pizza				
9. Ride a motor bike				
10. Manufacture a motor bike				

_____

FEA, The Energy Challenge

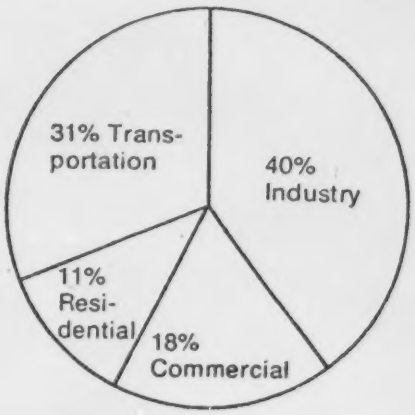
WHERE WE GET OUR ENERGY
HOW WE USE IT

Graph A divides our energy use into four groups. In what group do we use the most energy? *industry*

What ranks second? *transportation* In what ways do you use energy in each of these two groups? What group(s) gives you the most opportunity to cut down on your energy consumption?

Which groups use energy when you do each of the following. Check the box or boxes in the appropriate columns. (The first one is done for you.)

Graph A



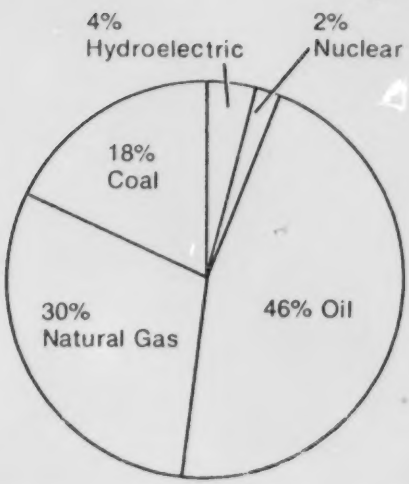
	*Industry	Transportation	Commercial	Residential
1. Take a hot bath				✓
2. Drive to a hamburger stand		✓	(✓)	
3. Fly in an airplane		✓		
4. Switch on air conditioning	✓			✓
5. Buy a new baseball			✓	
6. Ride a school bus		✓		
7. Blow dry your hair at home				✓
8. Buy a frozen pizza			✓	
9. Ride a motor bike		✓		
10. Manufacture a motor bike	✓			

** Every item that includes a product could also be checked under "Industry"*

FEA, The Energy Challenge

WHERE WE GET OUR ENERGY
HOW WE USE IT

Graph B



Graph B shows five primary sources of energy. These five sources supply Americans with most of their energy needs. They light and heat the buildings in which we live, work, and play. They fuel our vehicles. They run the machines that work for us and manufacture and process the goods we use and the foods we eat. Look at Graph B and answer these questions.

1. What energy source do we use most?_____

2. Which do we use mostly for heating our homes?_____

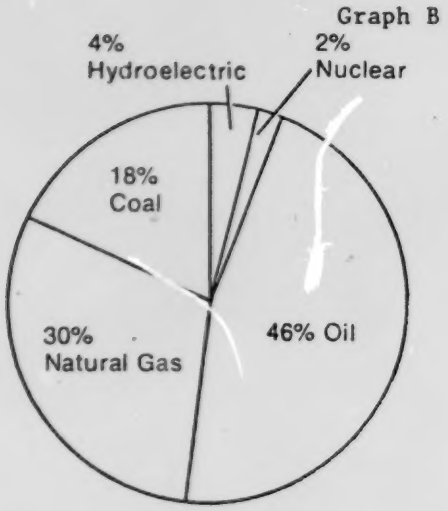
3. What energy source provides most of the fuel for our transportation?_____

4. Which one makes most of our electricity?_____

5. What is a possible reason why we use so little hydroelectric energy?_____

6. Why is electricity not shown on this chart?_____
_____

WHERE WE GET OUR ENERGY
HOW WE USE IT



Graph B shows five primary sources of energy. These five sources supply Americans with most of their energy needs. They light and heat the buildings in which we live, work, and play. They fuel our vehicles. They run the machines that work for us and manufacture and process the goods we use and the foods we eat. Look at Graph B and answer these questions.

1. What energy source do we use most? *oil*

2. Which do we use mostly for heating our homes? *natural gas*

3. What energy source provides most of the fuel for our transportation? *oil*

4. Which one makes most of our electricity? *coal*

5. What is a possible reason why we use so little hydroelectric energy? *not very much falling water*

6. Why is electricity not shown on this chart? *it is a secondary source*

FEA, The Energy Challenge

HOW LONG MIGHT OUR OIL AND NATURAL GAS LAST?

Both liquid petroleum, which is more commonly called oil, and natural gas are fossil fuels. Like coal, they were formed by the chemical changes of ancient plants and animals over millions of years and were trapped in rock layers of the earth.

Gasoline that runs our cars, trucks, and planes is made from petroleum. So are paints, insecticides, fertilizers, and many other manufactured products. Natural gas is a clean-burning fuel that heats many of our homes, cooks our food, and serves industry. Together, oil and natural gas supply 76 percent of our total energy needs.

Read the following items; then see if you can determine how long our oil and natural gas resources might last.

Item #1: During 1975, the United States produced from oil wells about *3 billion barrels* of oil (a barrel holds 42 gallons).

Item #2: The Federal Energy Administration estimates that our proved oil reserves in the U.S. (those known to exist and to be recoverable) is *38 billion barrels*.

Item #3: Many geologists figure that it is fairly certain that an additional *27 billion barrels* of oil reserves exist.

If this amount of oil still in the ground were all we had, and if we did not increase or decrease our production each year, in about how many years would the U.S. run out of domestically produced oil? (Add #2 and #3, and divide by #1.)

(#2) ____ billion barrels
+(#3) ____ billion barrels
_____
____ billion barrels
÷(#1) ____ billion barrels
_____
____ number of years

Item #4: The highest estimate is as much as *127 billion barrels* of additional domestic oil still undiscovered.

If Item #4 is true, and if we do not increase or decrease our production, how many years might our possible total oil resources last?

(On the back of this sheet, add #2, #3, and #4 and divide by #1. Put the number of years in this space.)

____number of years

FEA, The Energy Challenge

In the same way, determine how long our natural gas resources might last.

Item #5: During 1975, the U.S. produced for use about *20 trillion cubic feet* of natural gas.

Item #6: Our proved reserves at the end of 1974 were *240 trillion cubic feet*.

Item #7: Fairly certain reserves of natural gas are about *202 trillion cubic feet*.

If this amount of domestic natural gas was all the supply we had, it would last about how many years? (Add #6 and #7, and divide by #5. Put the answer in this space.)

____ number of years

Item #8: The highest estimate of undiscovered natural gas resources is *655 trillion cubic feet*.

If this amount is true, about how many years might our supply of natural gas last? (Add #6, #7, and #8, and divide by #5. Put answer in this space.)

____ number of years

BUT . . . the United States is now using each year almost double the oil that it produces from its own reserves. Where does this additional oil come from?

What could happen if our usage continues to increase each year?

What if oil and natural gas usage increases in other countries?

At what time in your life could the U.S. run out of oil and natural gas?

HOW LONG MIGHT OUR OIL AND NATURAL GAS LAST?

Both liquid petroleum, which is more commonly called oil, and natural gas are fossil fuels. Like coal, they were formed by the chemical changes of ancient plants and animals over millions of years and were trapped in rock layers of the earth.

Gasoline that runs our cars, trucks, and planes is made from petroleum. So are paints, insecticides, fertilizers, and many other manufactured products. Natural gas is a clean-burning fuel that heats many of our homes, cooks our food, and serves industry. Together, oil and natural gas supply 76 percent of our total energy needs.

Read the following items; then see if you can determine how long our oil and natural gas resources might last.

Item #1: During 1975, the United States produced from oil wells about *3 billion barrels* of oil (a barrel holds 42 gallons).

Item #2: The Federal Energy Administration estimates that our proved oil reserves in the U.S. (those known to exist and to be recoverable) is *38 billion barrels*.

Item #3: Many geologists figure that it is fairly certain that an additional *27 billion barrels* of oil reserves exist.

If this amount of oil still in the ground were all we had, and if we did not increase or decrease our production each year, in about how many years would the U.S. run out of domestically produced oil? (Add #2 and #3, and divide by #1.)

(#2)	*38*	billion barrels
+(#3)	*27*	billion barrels
	65	billion barrels
÷(#1)	*3*	billion barrels
	21+	number of years

Item #4: The highest estimate is as much as *127 billion barrels* of additional domestic oil still undiscovered.

If Item #4 is true, and if we do not increase or decrease our production, how many years might our possible total oil resources last?

(On the back of this sheet, add #2, #3, and #4 and divide by #1. Put the number of years in this space.)

64 number of years

FEA, The Energy Challenge

In the same way, determine how long our natural gas resources might last.

Item #5: During 1975, the U.S. produced for use about *20 trillion cubic feet* of natural gas.

Item #6: Our proved reserves at the end of 1974 were *240 trillion cubic feet.*

Item #7: Fairly certain reserves of natural gas are about *202 trillion cubic feet.*

If this amount of domestic natural gas was all the supply we had, it would last about how many years? (Add #6 and #7, and divide by #5. Put the answer in this space.)

22+ number of years

Item #8: The highest estimate of undiscovered natural gas resources is *655 trillion cubic feet.*

If this amount is true, about how many years might our supply of natural gas last? (Add #6, #7, and #8, and divide by #5. Put answer in this space.)

55 number of years

BUT . . . the United States is now using each year almost double the oil that it produces from its own reserves. Where does this additional oil come from?

We buy it from other countries.

What could happen if our usage continues to increase each year?

We will have to buy more or run out sooner.

What if oil and natural gas usage increases in other countries?

Competition for supplies will increase. Prices will rise.

At what time in your life could the U.S. run out of oil and natural gas?

SOLAR HEATER

Grade Level 4-12

Purpose: To demonstrate how a solar heater can be used to heat water for home use.

Concept: Using a simple apparatus, water can be efficiently heated by the sun (a free energy source) for use in the home.

Materials: Scrap wood sufficient to build a box roughly 33 cm x 72 cm x 8 cm, 5 meters black vacuum hose, 1 sheet of template cut in strips, thumb tacks, 1 gallon can, 2 electrical althread nipples, 4 nuts, 4 washers, graphite string packing. (Be sure the nipples fit the hose.) Clear plastic to cover. See model on following page.

Activity:

Procedure--

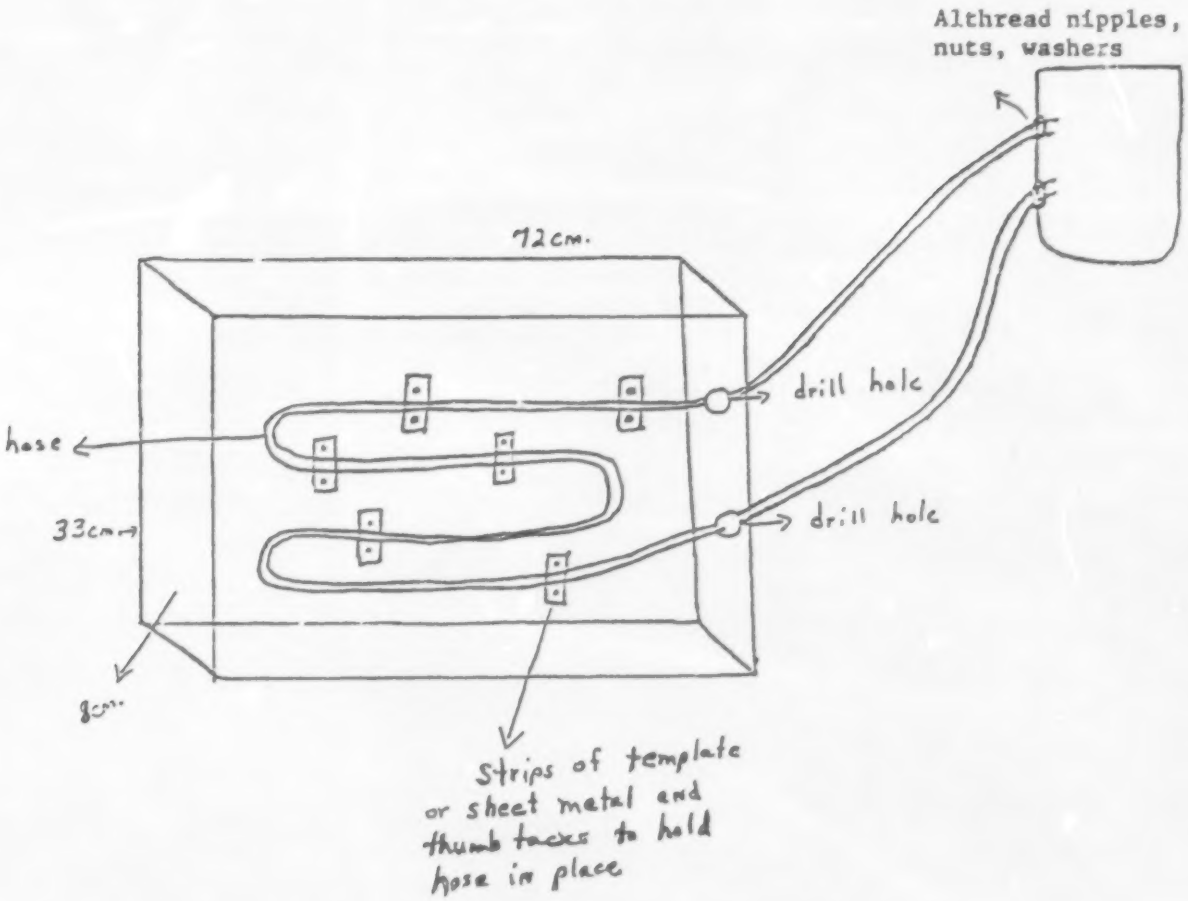
(1) Construct box, paint black (flat black paint).
(2) Cut templates, 2 cm x 8 cm (paint black).
(3) Drill holes in box.
(4) Place and anchor tubing in box with black tacks.
(5) Put nipples in can so hose can be put into can.
(6) Fill system with all the water it will hold. Blow out excess air. Cover box with clear plastic.
(7) Set solar box so it will receive maximum sunlight to the inside of the black box.
(8) Measure temperature of water at intervals of 5 minutes.
(9) Observe movement of water, through the system. Move the system to keep the sun on it to keep it efficient (each 20 minutes or so).

Questions--

(1) What makes the water temperature rise?
(2) What causes the water to move?
(3) Why is everything inside the box black?
(4) Should the can be black? Why?
(5) Should the can be insulated? Why?
(6) What happens if you add more turns in the tubing? More tubing?
(7) What happens if you tilt the heater away from or towards the sun?
(8) Is there a maximum temperature the heater can produce?

Robert Walsh, Sixth Grade Teacher, North Enid, Oklahoma.

(9) What happens if you stand the heater on end?
(10) What happens if you color the liquid? (Food coloring)
(11) What happens if you paint the can black?
(12) What happens if you insulate around the can?
(13) What happens if you take the plastic wrap off?
(14) What effect will adding reflectors along the sides of the heater produce?
(15) What happens if you use clear plastic tubing?
(16) Does the outside temperature make a difference? Why or why not?



SOLAR OVEN
(Modified)

Grade Level 4-12

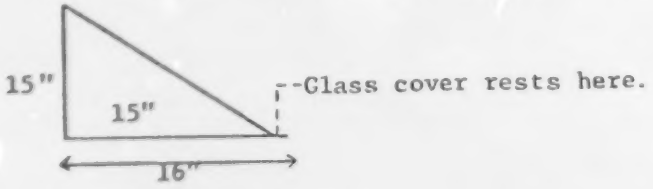
Purpose: To help the student recognize solar energy has potential to become an important alternate energy source.

Concept: Direct energy from the sun (solar) may be used to cook many foods. The energy source is free.

Materials:
Cardboard box
Aluminum foil (heavy duty)
Insulation
Sheet metal or template painted with flat black paint (paint must withstand high temperatures)
Oven thermometer
Glass cover (safety glass) which is clear, not tinted
Black pan for cooking
Food to cook
Stiff cardboard or thin plywood for reflectors

Activity:

Measure 16 inches across the bottom of the box and 15 inches high and cut box at 45 degrees angle. Line inside of box with aluminum foil so that it overlaps outside the box. Cover the outside of the box with foil also. Place a one-inch layer of fiber glass insulation inside the box (bottom, back, and ends). Use the sheet metal or template to make the inner oven wall. Paint black using flat paint which can withstand high temperatures. Cover the solar oven with glass. Duct tape around edges of the glass makes it easier and safer to handle. Tilt toward the sun. You can achieve approximately 300 degrees Fahrenheit (150° C) with this heater. To increase the temperature, make four reflectors the same size as the glass cover and tape them to the oven, reflecting more solar energy into the oven. To make a reflector just cover stiff cardboard with aluminum foil. Use a heavy black pan to cook in.



Side view of oven

ERIC/SMEAC: Energy Activities for the Classroom, modified by Pat Kellogg, Ada Middle School, Ada, Oklahoma.

SOLAR ENERGY

Grade Level 4-12

Purpose: To demonstrate how solar energy can be transferred to heat energy for our homes.

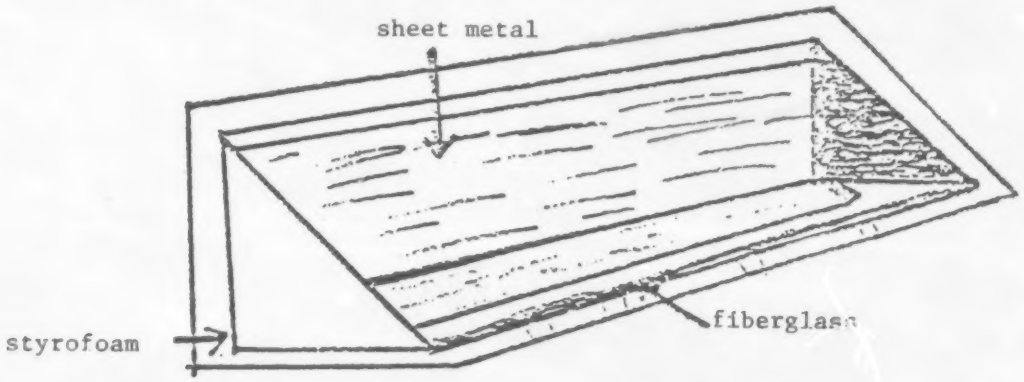
Concept: Presently, most of our energy requirements are met through using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

Reference: Daniels, Farrington. Direct Use of the Sun's Energy, Ballantine Books, New York. Science Teacher, Vol. 39, March 1972, Page 36, "Solar Energy". Activity suggested by Joy McDonald, Teacher, East Elementary School, Urbana, Ohio.

Activity:

1. After some simple experiments to show the heating power of the sun, involve the students in constructing a solar-radiation oven. Materials needed are: About 30 sq. in. of sheet metal painted one side with flat black paint; 1-5/6 sq. yd. of 2- to 4-inch styrofoam or a wood frame; 1-5/6 yd. of 1-inch fiberglass insulation; and a glass cover for the front. An oven thermometer and one to check water temperature would also be useful.

   Students should dry apples, heat water, and bake cup cakes or do other cooking in the solar oven.



2. Plan a field trip to a solar-heated home to understand how this can operate.

3. Show transparencies and slides of solar radiation collectors, cells, furnace, solar-powered steam engines, projected satellite solar-power station, and solar-heated homes. Discuss.

SOLAR COOKING

Grade Level 4-12

Purpose: To recognize the potential value of direct sunlight in providing some of our energy needs.

Concept: By reflection, solar energy may be used to cook food.

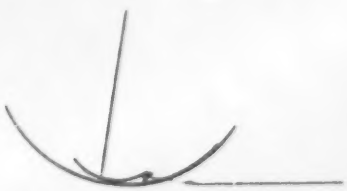
Materials:
Paper Clips (large)
Rubber Cement
Umbrella
Poster Board
Aluminum Foil
Skillet (black all over)
Oven Thermometer
Food to cook

Cost--$5.00-$7.00

Activity: Procedure--

Open the umbrella, measure the panels and cut new panels out of poster board large enough to overlap slightly. Cover each poster board panel with rubber cement then heavy weight aluminum foil. Use paper clips to mount these panels inside the open umbrella. Measure the radius of the umbrella. Cut off the handle to the same length as the radius of the umbrella. (A string may be used to measure the radius. Use this pointer to direct the umbrella toward the sun. Locate the hot spot (focal point). Put the skillet over the hottest spot and cook some food. To increase efficiency, cut a hole in a paper plate the size of the pointer, cover the plate with foil and lay it over the pointer pushing it down to the center of the umbrella. This helps hold the panels in place.

Example: If the diameter of the umbrella is 36 inches then the length of the pointer should be 18 inches (radius = $\frac{\text{diameter}}{2}$).



Paper plate covered with foil

Robert Walsh, Teacher, North Enid, Oklahoma, Schools.

LET'S SHED A LITTLE LIGHT ON THE SUBJECT

Grade Level 4-12

Objective: To demonstrate what solar energy is and how it can be used more effectively.

Activity:

1. To demonstrate that sunlight is a type of energy. Place a Radiometer in direct exposure to the sun. Have the students observe the speed of the vane. Now block off the sunlight. Have them explain what has happened.

2. The effect of solar energy on the growth of plants can be easily shown by taking two healthy plants of a similar size and variety. Place one in sunlight and the other in darkness. Have the student observe the two plants over a period of time, noting changes in growth, coloration and general appearance of the plants.

3. To demonstrate the "greenhouse effect" the following experiment can be done:

   Obtain two small cardboard boxes. Place a thermometer in each box and position them in a sunny location. Over the opening of one of the boxes place a sheet of window glass; leave the other box uncovered. Have the students observe the two thermometers. Discuss reasons for the difference in temperatures. Note: The results of the experiment can be improved by insulating the two boxes.

   Have students discuss and research solar heating in homes. A home in District Heights, Md., uses solar energy to cut the heating bill in half. The University of Delaware has developed a house which converts solar energy to electricity as well as heat.

4. To demonstrate how sunlight can be concentrated to produce higher temperature, the following activities can be done:

   A. Place a thermometer in direct sunlight. Observe the temperature. Now place the bulb end of the thermometer up through the reflector of a flashlight (see diagram on next page). Vary the distance of the thermometer through the reflector until the focal point is located (point at which highest temperature will be reached). Caution: The thermometer will burst if left at the focal point for

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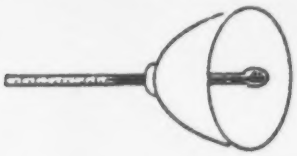
Energy Activities for the Classroom, West Virginia Department of Education, 1975.

too long a time. Have students compare the differences in temperatures generated. To demonstrate more dramatically the high temperatures that are generated by the sun shining on the reflector, a match may be substituted for the thermometer. Make certain that no one attempts to measure the temperature of the burning match with a thermometer; the thermometer will quickly burst if this is attempted.



B. A similar type of demonstration as that in Activity A can be done by using a magnifying glass. Position the lens in the sunlight so that the smallest possible spot of light is produced. This spot of light may be focused on a thermometer or various types of easily combustible materials to demonstrate the high temperatures that are reached. Again, care must be exercised to avoid bursting thermometers or setting fires which get out of control.

C. To show how heat concentrating devices such as the parabolic reflector can be used as a water heater or furnace, line the inside of an umbrella with tin foil and place it in direct sunlight. Locate the focal point of the reflector with a thermometer or piece of paper and position a container of water at this point. Observe the rate at which the temperature of the water rises. Have the students discuss how this device might be adapted for use in the home. (It has been estimated that solar furnaces will be in use in tropical and sub tropical regions by 1990).

5. To demonstrate how solar energy can be converted to electrical energy, the following activities can be performed:

A. Connect a photo electric cell to a sensitive electrical measuring device such as a galvanometer. Expose the cell to various amounts of sunlight. Have the students observe the galvanometer and explain the results.

B. Obtain a light meter such as those used by photographers. Take and record light readings in bright sunlight, in partial shade, in full shade, and inside a classroom. How do the readings compare?

For Upper Grades Only:

Use a constant light source such as a flashlight or an incandescent bulb of a fairly high intensity (100 watts or more). Measure the light intensity at the following distances from the light source: six inches, one foot, two feet, four feet, eight feet and sixteen feet. What appears to be the relationship between light intensity and the distance from the light source?

C. Another good activity on the solar cell can be performed through the use of a kit put out by the Bell System. The kit is called the Bell System Science Experiment #1. Directions come with the kit.

D. Have students research how orbiting satellite collection systems obtain solar energy from the sun and relay it to earth.

E. Resources for further study: *"How to Make a Solar Still"* plans for building a small windmill to generate an electric current or pump water.

Brace Research Institute
MacDonald College of McGill Univ.
Ste-Anne de Bellevue
Quebec, Canada H9X3 Mi

model solar homes with solar heater and arc water pump

Edmund Scientific Co.
555 Edscorp Bldg.
Barrington, N.J. 08007

CONSTRUCTING A WINDMILL

Grade Level 4-12

Objective: To demonstrate that wind can be used to do work.

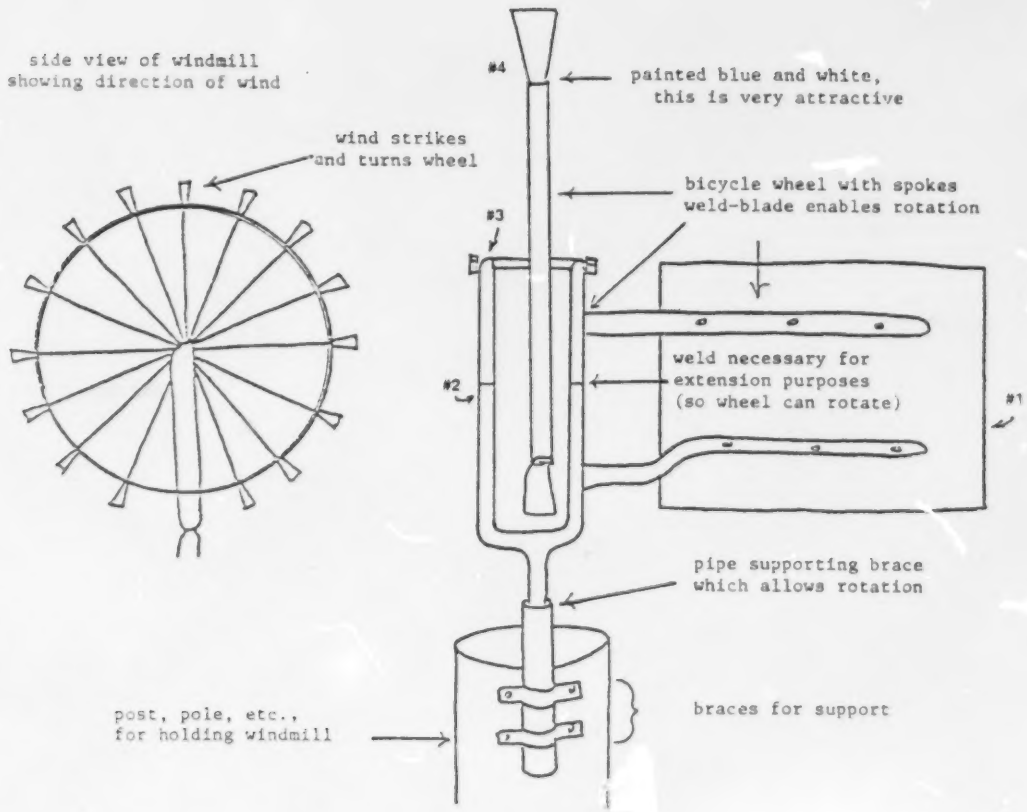
Materials: Old bike wheel, front braces (fork) of frame that holds wheel, pipe, metal sheeting, rivets, or nuts and bolts. Flat strips of metal bracing approximately 3/16" thickness.

Activity: Cut metal sheeting into a 12" x 8" rectangular shape (direction of wind) rounding off the corners. Next cut and extend by a weld or nuts and bolts the frame that holds the wheel in place (step #2 on drawing). Place wheel into grooves so that it may rotate (turn). Now cut metal flaps or blades that will be attached to wheel. Bend and rivet into place. Step 5 will need a weld to the frame extending outward (flat strips to frame). Large 12" x 8" sheet is now attached to metal strips. To mount the windmill a piece of pipe may be attached to a pole and upper end of front wheel brace (fork) lowered into pipe. Windmill should now rotate and turn according to the wind.

actual size

holes drill to attach blade to wheel

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

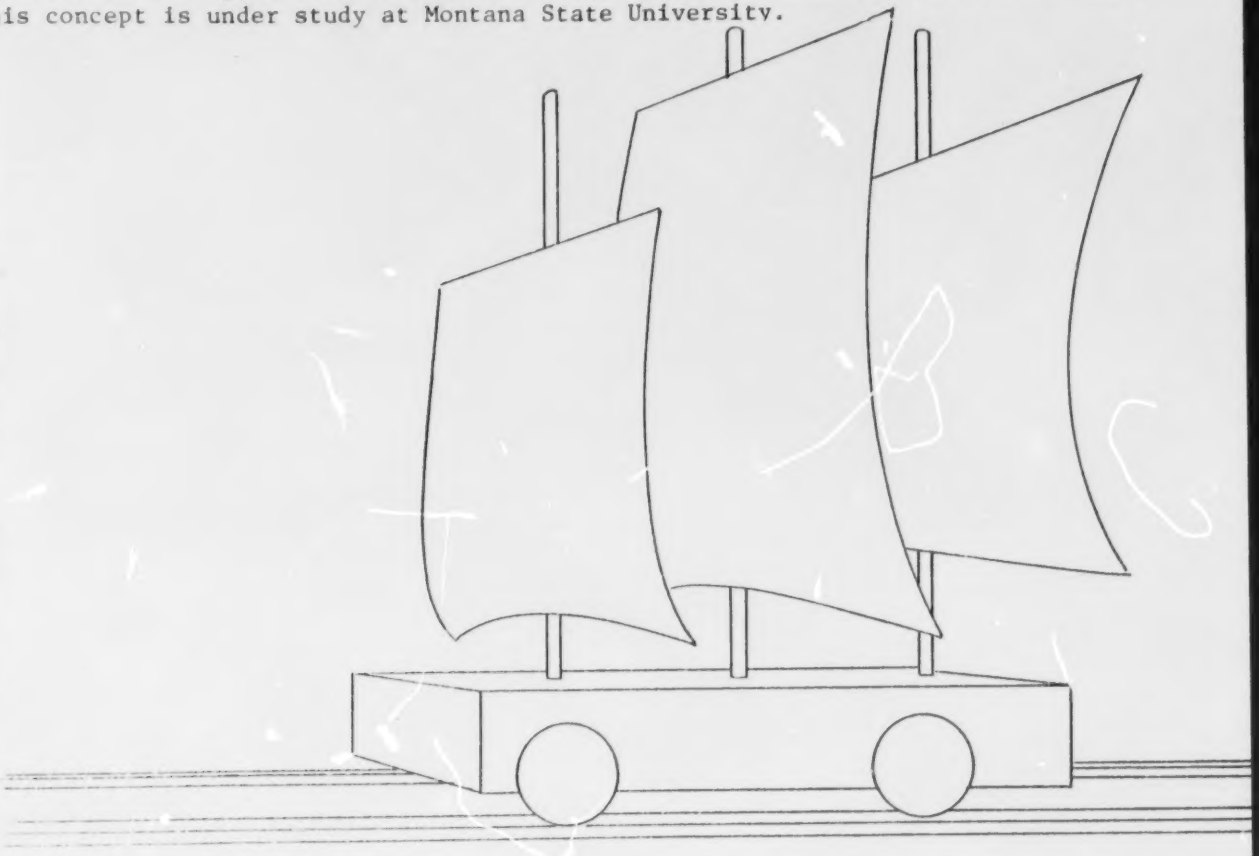


This model can also be erected and accurately used as part of a homemade weather station (determining both speed and direction of the wind). Efficiency test--try it with vanes mounted between the spokes.

SAIL-TRAIN, same principle as car

Grade Level 4-12

It would drive a generator to feed a storage device, or connect directly to high lines. This concept is under study at Montana State University.



POWER DIRECTLY FROM THE SUN

Grade Level 7-12

Purpose: To show power directly from the sun.

Concept: Metals expand when heated and contract when cooled.

Materials:

2 ball bearings--plain (without shields) 1/4" bore, 5/8" outer diameter. The cheapest source is A. Jaegers, 691 Merrick Road, Lynbrook, New York 11563, cat. no. 3302674, 25¢ ea. postpaid (minimum order $2.00). Some bearings will be coated with heavy grease or rust preservative; this must be removed with paint thinner or solvent. The bearings must spin freely. Oil with 1 or 2 drops of sewing machine oil.

1 aluminum tube--3/4" outer diameter, 6 feet long. Sears cat. no. 9A7333C, $1.79, 2 lb. Also available at hardware stores. Paint this flat black with a very thin coat (a thick coat of paint will prevent rapid heating and cooling of the aluminum tube). Spray can paint may be applied very thinly and is easy to use.

5 lb. box of patching plaster--Sears cat. no. 30A59305, 59¢, 5 lb. 8 oz. Also available at hardware stores.

2 machine screws--2" long, fully threaded. For each screw obtain 2 flat washers and 2 hexagonal nuts. Hardware stores have these.

4 pieces of 1 x 4 lumber 9" long--make a 1/4" hole about 1" from the end in the center of the pieces. Nail into stands as shown on the sketch (a pair of #6 common or #8 box nails for each stand are about the right size).

2 pieces of .012 brass shim stock 1/4" wide, 1 15/16" long--these might not be obtainable without buying a whole roll of shim stock. Find some round object about 3/8" or 1/2" in diameter and bend the shim stock over the object to form a ring. The shim stock will take up the clearance between the bearing and the inside diameter of the aluminum tube so that the bearing will fit tightly into the tube.

1 piece of manila folder material 3" x 4 7/8"--first form around some 1/2" diameter object; then tightly roll the material around the aluminum tube, gluing the paper to itself in several spots (Duco or rubber cement works well). Hold down the final

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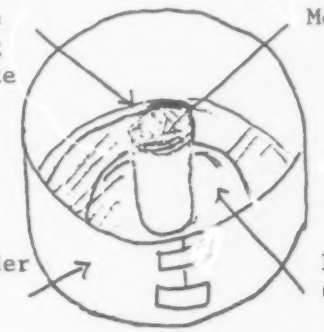
Public Affairs Office, NASA Ames Research Center, Moffett Field, CA 94035.

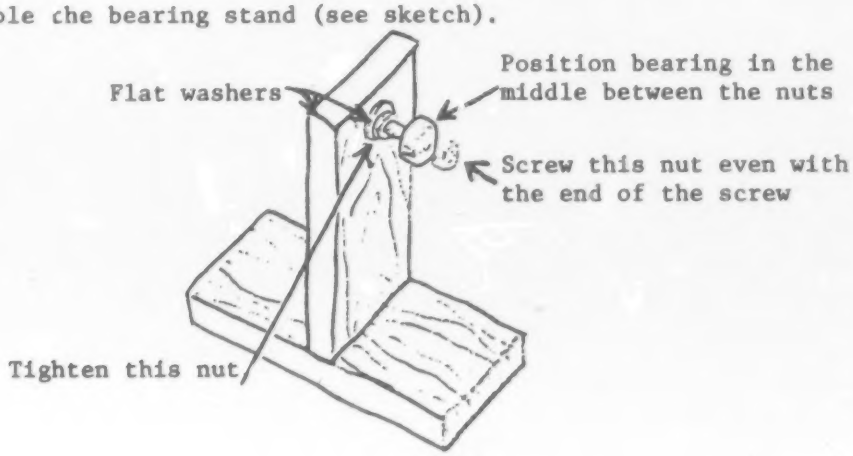
edge with masking tape. Rub candle wax on the paper tube (as a parting agent); then remove from the aluminum tube. The paper tube will be used as an inner form. Roll some modeling clay into a cylindrical shape a bit smaller than the paper tube and expand it inside of the paper tube by standing the clay-filled tube on a table and pressing down on the clay with the thumb so that the clay will expand in diameter to solidly fill the paper tube (the clay will keep the paper tube round and also be used to fasten it to a plastic coffee can lid).

1 plastic lid from a 3 lb. coffee can--cut 2 strips of manila folder material 9 13/16" by 3" and form them into a hoop with masking tape. The hoop should just go around the plastic lid. Fasten the paper tube to the center of the plastic lid with the modeling clay as described. Hold the lid up to the light to make sure the paper tube is well centered (the plastic lid has a thicker spot in the center which is helpful in locating its center). Place the finished mold on a table.


Paper tube. Rotate tube while pressing down on clay to make strong joint with plastic
Modeling clay
Hoop of manila folder material
Plastic coffee can lid 6 1/4" diameter

Pour 3 cups of water into a container and add patching plaster (stirring frequently) until the mixture has the consistency of soft pudding. Only about 2/3 of the patching plaster will have been used. Pour this into the mold previously made. Level the mixture; then jar the table to settle the mixture to a smooth surface. Let harden about 1 day before stripping the mold from the flywheel. The flywheel can now be glued to the center of the aluminum tube (use epoxy glue). The epoxy will take about 1 day to harden.

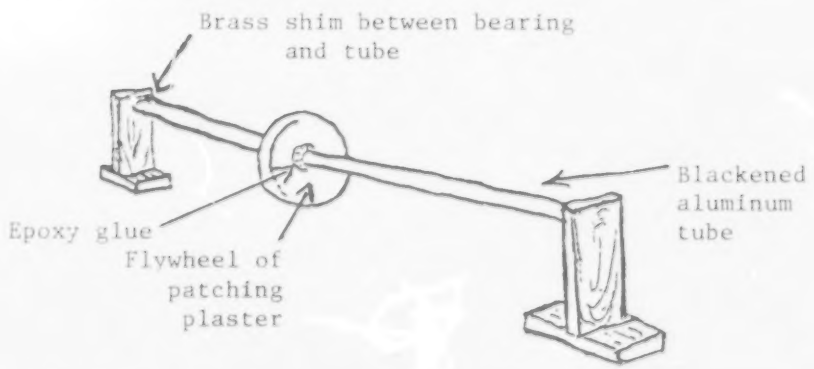
Assemble the bearing stand (see sketch).


Flat washers
Position bearing in the middle between the nuts
Screw this nut even with the end of the screw
Tighten this nut

Put the shim stock ring part way into the aluminum tube and push in the bearing and ring so that they are even with the end of the tube. Don't worry if the bearing and ring are pushed in too far: just pull them out and try again. Withdraw the stands until a few screw threads show (the bearing should not touch either nut). With the tube assembled on the stands the engine is complete except for balancing.

One spot of the flywheel will be heavier than the remainder, and the flywheel will quickly turn until this spot is on the bottom. You can mark this spot with a pencil and verify that no matter to what position the flywheel is turned, the pencil spot will stop at the bottom. The idea is to remove this heavy spot by carving away the bottom material (use a pocket knife). Carve and test. As perfect balance is approached the heavy spot will move slowly toward the bottom, until finally the flywheel shows no preferred spot for the bottom position--the flywheel is then balanced. If too much material is carved from the bottom this region will now be lighter than the rest and always stop at the top. Don't worry; just treat the new lowest spot as being too heavy and proceed to carve away from it (only remove less material this time!)

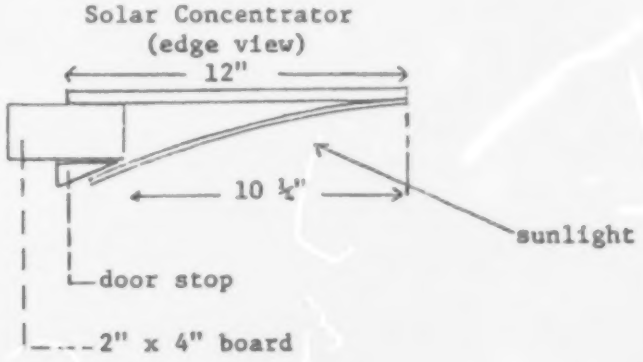
Heat should be applied to the top region of the aluminum tube near the flywheel (the portion near the bearings is ineffective). Heat applied to the bottom works in the wrong direction; it will slow the engine down. This is a good point to remember if the engine is placed on a hot surface to be operated from the sun. Cool asphalt by wetting it down, for example. The amount of heat required to operate the engine, and how fast it will run depend on how free the bearings are and how well balanced the flywheel is. The engine can be operated indoors with the aid of a heat lamp or two, or outside from the sun.

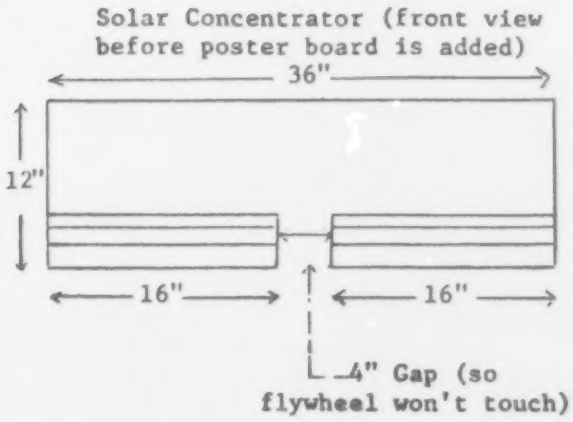


The materials for this solar engine were chosen for their availability and low cost, not for performance. A thinner tube of a higher strength material would greatly improve the power and efficiency of the engine. The objective here is to leave as a challenge the idea of producing power from the sun without pollution and without consuming the earth's limited resources.

SOLAR CONCENTRATOR
(for use with Solar Engine)

For a bit of extra cost and effort a solar concentrator can be made from lumber and poster board to hold aluminum foil in the desired shape, a parabola. The concentrator will direct about 3 times as much sunlight on the painted aluminum tube, increasing its power and speed about 3 times over that for direct sunlight. Test its light pattern by resting the concentrator on the ground (facing the sun); then hold a piece of paper about 2" above the ground in front of the concentrator. Now move the paper up and down and tilt the concentrator away from or toward the sun until the light pattern is smallest and brightest. This is the best distance and tilt angle to use with the concentrator on the solar engine. (Remember, heat the uppermost part of the tube!)





Nail poster board only, use a nail about every 2". Then daub many small spots of glue and apply aluminum foil, shiny side showing. Smooth out wrinkles with a soft rag.

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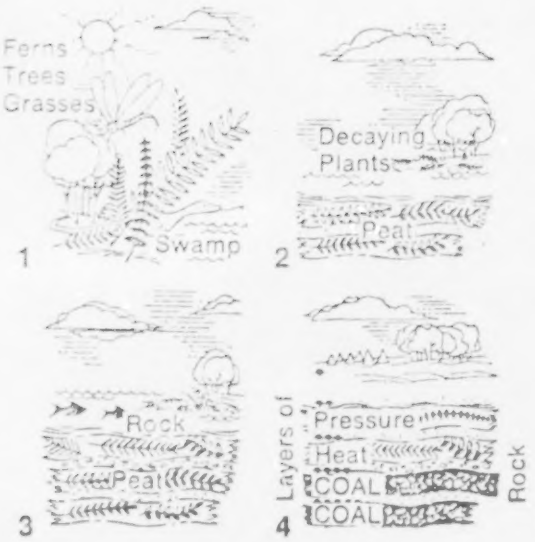
BEST COPY AVAILABLE.

FOSSIL FUELS: COAL, OIL, AND NATURAL GAS

How Coal was Formed



PLACE THE NUMBER OF EACH PICTURE IN FRONT OF THE DESCRIPTION THAT FITS IT BEST.

2 When the giant plants died, they formed rotted vegetable matter called *peat*. For thousands of years, plants grew, died, and formed layer upon layer of peat.

4 When the seas were gone again, heat and pressure from the layers of rock changed the peat into coal.

1 More than 250 million years ago, forests of gigantic ferns, trees, and grasses covered vast swamp lands and stored up energy from the sun.

3 Later, when the surface of the earth changed, seas covered the land and deposited layers of chale, limestone, and other rock on the peat.

FEA, The Energy Challenge

How Coal is Mined

Strip or Surface Mining	Deep or Underground Mining
Uses huge bull dozers and power shovels to remove coal from a shallow seam near the earth's surface.	Tunnel or shaft is built into the earth to the seam of coal sometimes many hundreds of feet below the surface. Workers and equipment remove the coal through the tunnel or shaft.

Read each set of statements below. If there were nothing else to consider, would you think that surface or deep mining (or both) is the best way to obtain coal? Write your choices on the blanks at the left, using S (for surface) or D (for deep).

	Surface Mining	Deep Mining
___ 1.	Each miner can produce 30 tons of coal a day.	Each miner can produce 10 tons of coal a day.
___ 2.	90 percent of the coal in a surface mine can be removed.	50-60 percent of the coal in a deep mine can be removed.
___ 3.	In 1974, surface-mined coal cost $11.11 a ton.	In 1974, deep-mined coal cost $19.86 a ton.
___ 4.	Forest and fields, along with their topsoil, are turned over before the coal is removed--at a rate of 1000 acres a week. New laws in every state require land reclamation, but the cost is added to the price of coal.	Much less damage to land and environment.
___ 5.	Some coal, very close to the earth's surface, can only be recovered by surface mining.	Some coal, very deeply buried, can only be recovered by deep mining.

It would be easy to decide how to mine coal if there were only one set of facts to consider. As you have seen, however, there are many. What would you say is the main advantage of surface mining?

What would you say is the main advantage of deep mining?

Can you think of a compromise?

How Coal is Mined

Strip or Surface Mining	Deep or Underground Mining
Uses huge bull dozers and power shovels to remove coal from a shallow seam near the earth's surface.	Tunnel or shaft is built into the earth to the seam of coal sometimes many hundreds of feet below the surface. Workers and equipment remove the coal through the tunnel or shaft.

Read each set of statements below. If there were nothing else to consider, would you think that surface or deep mining (or both) is the best way to obtain coal? Write your choices on the blanks at the left, using S (for surface) or D (for deep).

	Surface Mining	Deep Mining
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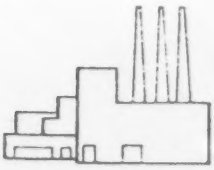
S	2. 90 percent of the coal in a surface mine can be removed.	50-60 percent of the coal in a deep mine can be removed.
S	3. In 1974, surface-mined coal cost $11.11 a ton.	In 1974, deep-mined coal cost $19.86 a ton.
D	4. Forest and fields, along with their topsoil, are turned over before the coal is removed--at a rate of 1000 acres a week. New laws in every state require land reclamation, but the cost is added to the price of coal.	Much less damage to land and environment.
both	5. Some coal, very close to the earth's surface, can only be recovered by surface mining.	Some coal, very deeply buried, can only be recovered by deep mining.

It would be easy to decide how to mine coal if there were only one set of facts to consider. As you have seen, however, there are many.
What would you say is the main advantage of surface mining?
economic
What would you say is the main advantage of deep mining?
environmental
Can you think of a compromise?

HOW COAL IS USED

This activity follows coal from the mine to your electric lights. Cut out the pictures and place (or paste) each in the appropriate box.



1)

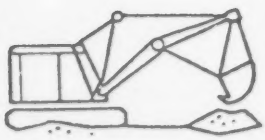
1. Coal is mined either by surface or underground mining. Before it leaves the mine, it is cleaned, crushed, and sorted.

2)

2. About 2/3 of our coal is transported by rail, much of it in special cars. One coal train can carry as much as 15,000 tons per trip.

3)

3. 46 percent of U.S. electrical generators are powered by coal. Power plants burn coal to turn water into steam. The steam turns a turbine, a series of wheels with vanes like a windmill. The turbine rotates coils of wire in a generator through a magnetic field to produce electricity.



4)

4. Electricity is transported on wires at very high voltages. Electricity is usually not shipped more than 600 miles by wire because of expense and loss of energy. Only 26 percent of the original energy remains when the electricity is used.

5)

5. Electricity lights the lamps in your home. How many other uses of electricity in your home can you name? Write them on the back of this paper. Then place a star before those you think you can do without.

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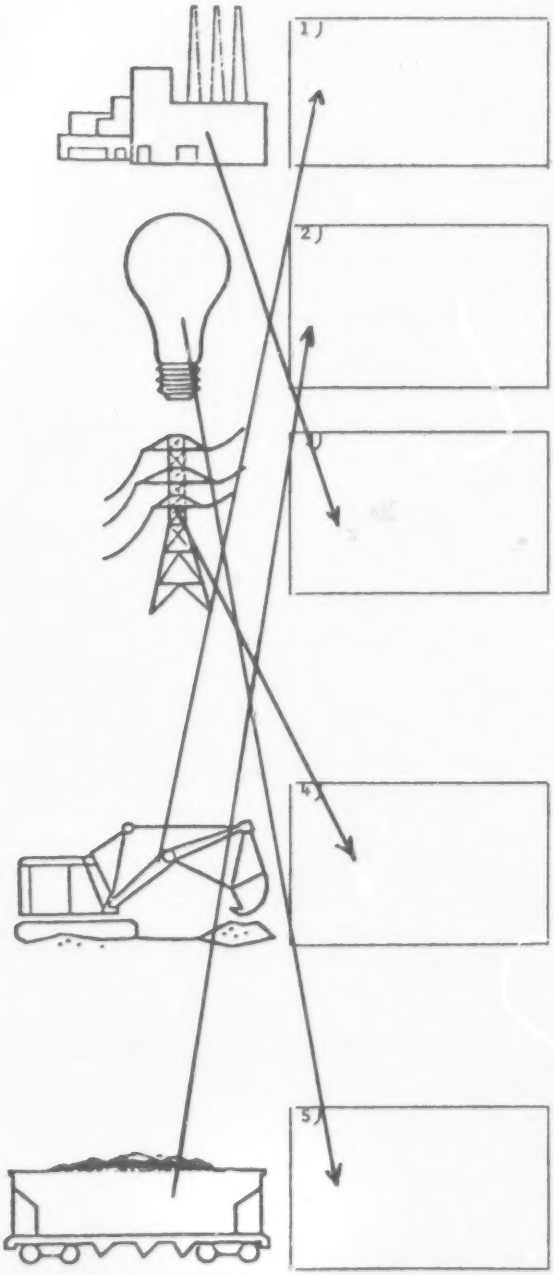
HOW COAL IS USED

This activity follows coal from the mine to your electric lights. Cut out the pictures and place (or paste) each in the appropriate box.



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SOME FACTS ABOUT COAL

Decide whether each of the following facts is a problem (P) or an opportunity (O). Put a P or an O--or both--in each blank. On the back of this sheet, write down ways some of the problems could be overcome. Compare ideas with your classmates.

_____ 1. 90 percent of U.S. fossil fuel reserves (coal, oil, natural gas) are coal.

_____ 2. Some deep mines are dangerous.

_____ 3. 50 percent of our mineable coal is in the western United States.

_____ 4. We have enough coal to last for 350 years, at current level of use.

_____ 5. Mining coal can cause damage to the environment.

_____ 6. In the future, we will rely more on coal as a source for synthetic oil and gas.

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P 2. Some deep mines are dangerous.

O/P 3. 50 percent of our mineable coal is in the western United States.

O 4. We have enough coal to last for 350 years, at current level of use.

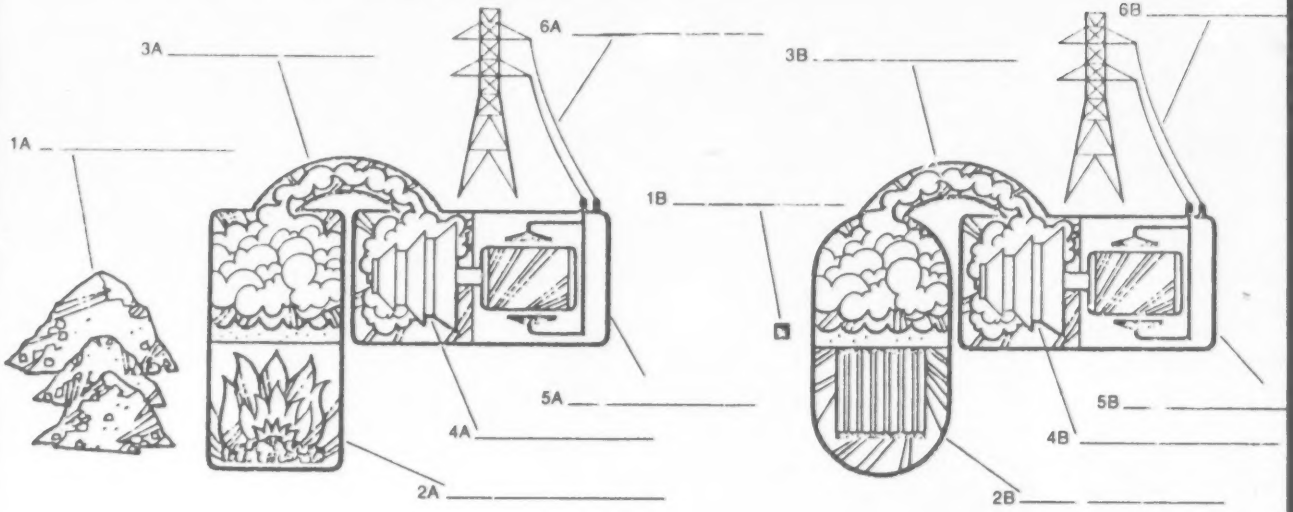
P 5. Mining coal can cause damage to the environment.

O 6. In the future, we will rely more on coal as a source for synthetic oil and gas.

NUCLEAR ENERGY (Part 1)

One of the energy resources being considered to supplement our limited oil and natural gas supplies is nuclear power, created by the splitting apart of atoms of uranium. This power can be captured and used to create steam which produces electricity much as the power of burning coal is used in an electric generating plant.

The diagrams below show two kinds of electric power plants. They are much alike except that one is powered by nuclear energy produced in a nuclear reactor. Can you label the parts of the two plants. All the words you need appear at the bottom of the page. An encyclopedia or other reference book may help you.



FOSSIL FUEL ELECTRIC GENERATING PLANT
NUCLEAR POWERED ELECTRIC GENERATING PLANT

GENERATOR
BOILER
STEAM
TRANSMISSION LINES
TURBINE
TRANSMISSION LINES
FUEL (1 lb.)
TURBINE
STEAM
REACTOR
GENERATOR
FUEL (2½ million lbs.)

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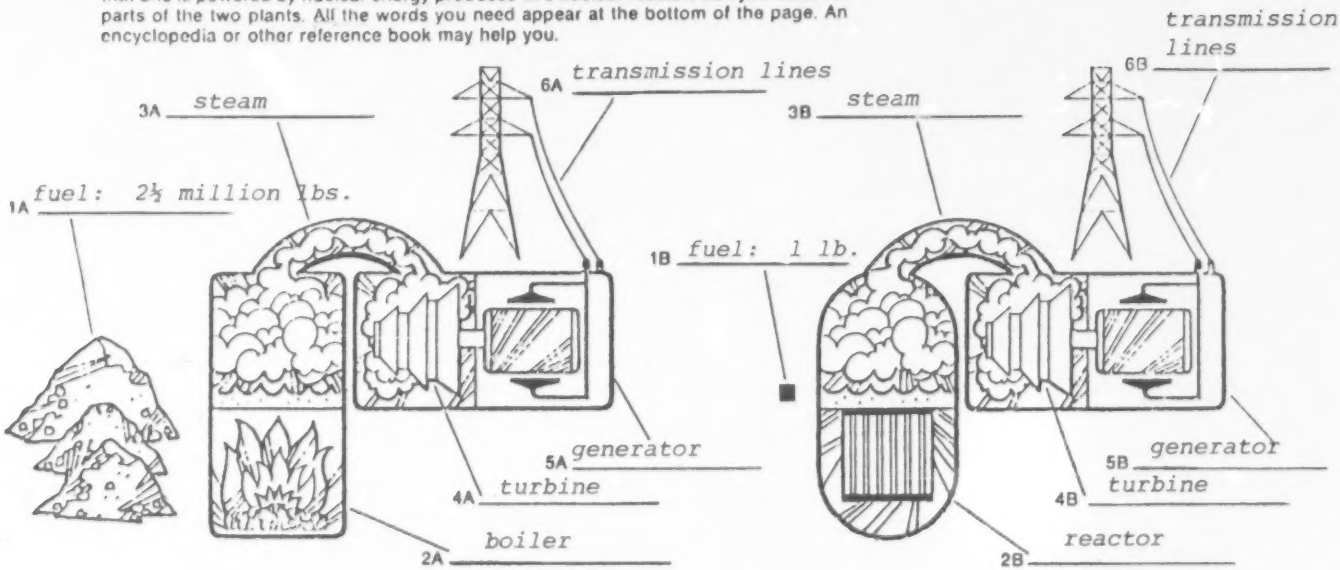

A *Fossil Fuel Electric Generating Plant*

B *Nuclear-Powered Electric Generating Plant*

FOSSIL FUEL ELECTRIC GENERATING PLANT
NUCLEAR POWERED ELECTRIC GENERATING PLANT

GENERATOR
BOILER
STEAM
TRANSMISSION LINES

TURBINE
TRANSMISSION LINES
FUEL (1 lb.)
TURBINE

STEAM
REACTOR
GENERATOR
FUEL (2½ million lbs.)

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NUCLEAR ENERGY (Part 2)

The following is a list of benefits and problems associated with nuclear power plants. A key word or phrase in each item is printed in italics. Read the list and put a (B) in the blank if it is a benefit, a (P), if it is a problem.

____	Less need for mining and *TRANSPORT* of fuel	____	Overall *COST* of electricity will be less than with fossil fuels
____	No *POLLUTANTS* from burning fuel	____	Higher *COST TO BUILD*
____	Less reliance on *IMPORTED FUEL*	____	Large amounts of *PLUTONIUM* could lead to spread of nuclear weapons
____	Could be targets for *TERRORISTS*	____	Possibility of *RADIATION ESCAPING*
____	Reactors produce *LESS WASTE* than fossil fuel plants do	____	*RADIOACTIVE WASTE* must be handled and disposed of safely for thousands of years

Now that you have identified the problem areas, look at the arguments below. Each one concerns a problem area and offers arguments for (PRO) and against (CON) expansion of nuclear energy. Complete the arguments by inserting a *KEY WORD* (above) into the blanks for each problem area.

PRO: The _____ is made into a type of glass or ceramic, put into special containers, and stored in places like salt beds which have been undisturbed for millions of years.

CON: It takes thousands of years for the _____ to lose its radioactive properties. We cannot assure safe disposal for thousands of years and future societies may be hurt.

PRO: In more than 20 years of commercial nuclear power plant operation, no one has suffered any ill effects brought on by _____.

CON: There's always a chance that an accident or mechanical malfunction could present the danger of _____.

PRO: Regulations and safeguards can be strictly enforced to keep the _____ out of the hands of terrorists. This radioactive waste is usually sealed in an unbreakable capsule right after the fuel processing.

CON: Just 10 pounds of radioactive _____ is enough to make an atom bomb.

NUCLEAR ENERGY (Part 2)

The following is a list of benefits and problems associated with nuclear power plants. A key word or phrase in each item is printed in italics. Read the list and put a (B) in the blank if it is a benefit, a (P), if it is a problem.

B ____ Less need for mining and *TRANSPORT* of fuel

B ____ No *POLLUTANTS* from burning fuel

B ____ Less reliance on *IMPORTED FUEL*

P ____ Could be targets for *TERRORISTS*

B ____ Reactors produce *LESS WASTE* than fossil fuel plants do

B ____ Overall *COST* of electricity will be less than with fossil fuels

P ____ Higher *COST TO BUILD*

P ____ Large amounts of *PLUTONIUM* could lead to spread of nuclear weapons

P ____ Possibility of *RADIATION ESCAPING*

P ____ *RADIOACTIVE WASTE* must be handled and disposed of safely for thousands of years

Now that you have identified the problem areas, look at the arguments below. Each one concerns a problem area and offers arguments for (PRO) and against (CON) expansion of nuclear energy. Complete the arguments by inserting a *KEY WORD* (above) into the blanks for each problem area.

PRO: The *radioactive waste* is made into a type of glass or ceramic, put into special containers, and stored in places like salt beds which have been undisturbed for millions of years.

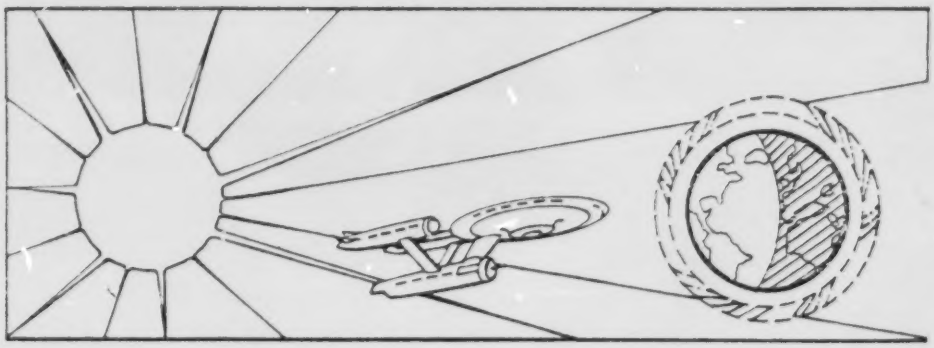
CON: It takes thousands of years for the *radioactive waste* to lose its radioactive properties. We cannot assure safe disposal for thousands of years and future societies may be hurt.

PRO: In more than 20 years of commercial nuclear power plant operation, no one has suffered any ill effects brought on by *radiation escaping*.

CON: There's always a chance that an accident or mechanical malfunction could present the danger of *radiation escaping*.

PRO: Regulations and safeguards can be strictly enforced to keep the *plutonium* out of the hands of terrorists. This radioactive waste is usually sealed in an unbreakable capsule right after the fuel processing.

CON: Just 10 pounds of radioactive *plutonium* is enough to make an atom bomb.



LET'S POWER SPACESHIP EARTH WITH THE SUN

The sun, 93 million miles away from earth, sends more radiant energy toward us every second than people have used in the course of human history. Thirty percent of this energy is reflected back into space by our atmosphere. Much of the remaining radiant energy of the sun heats the land and the water; it evaporates water and melts the snows. It is the source of energy that creates the winds and great ocean currents, and it warms the atmosphere that surrounds us.

Energy from the sun interacts with oxygen at the top of the earth's atmosphere to create a layer of ozone that protects us from lethal amounts of the sun's radiation. Solar energy reacts with plants in the chemical process of photosynthesis to provide the stored energy that fuels life. Coal and oil and natural gas, once swamp jungles of the ancient earth, are stored solar energy. All of these are ways we benefit from the sun's energy directly.

We also benefit indirectly from the sun's energy when that energy comes to us "secondhand." The electricity generated by a windmill, for example, is the sun's energy once removed. So, too, is the energy our bodies get from the food we eat.

Less than one percent of the incoming solar energy is used to sustain plant and animal life, yet this amount is many times greater than the total electric generating capacity of the entire world. The sun could be an important answer to our energy dilemma. All we have to do is find the key to the bank.

Humans from the dawn of history have put the energy from the sun to work to keep warm or to grow food, or by harnessing the wind. In what ways did early people use the sun to do work for them?

What has the energy from the sun made possible in your life today?

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Put a D beside each of the following things that result from energy received directly from the sun. Put an I beside each thing that results indirectly from the sun's energy.

_____	coal deposits	_____	sugar cane
_____	sailboats	_____	candy bar
_____	salt flats	_____	electric heater
_____	gasoline	_____	leaves turning green
_____	photosynthesis	_____	ocean currents
_____	mountain streams	_____	steam engine
_____	Hoover Dam	_____	ozone layer of the atmosphere

THINK ABOUT IT:

1. Why is the sun called the source of all energy except nuclear?

2. Imagine life on earth in the future if we learn to harness the power of the sun to provide heat, light, and electricity. What problems would be solved? What problems might be created?

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D	coal deposits	D	sugar cane
I	sailboats	I	candy bar
D	salt flats	I	electric heater
I	gasoline	D	leaves turning green
D	photosynthesis	D	ocean currents
D	mountain streams	I	steam engine
I	Hoover Dam	D	ozone layer of the atmosphere

THINK ABOUT IT:

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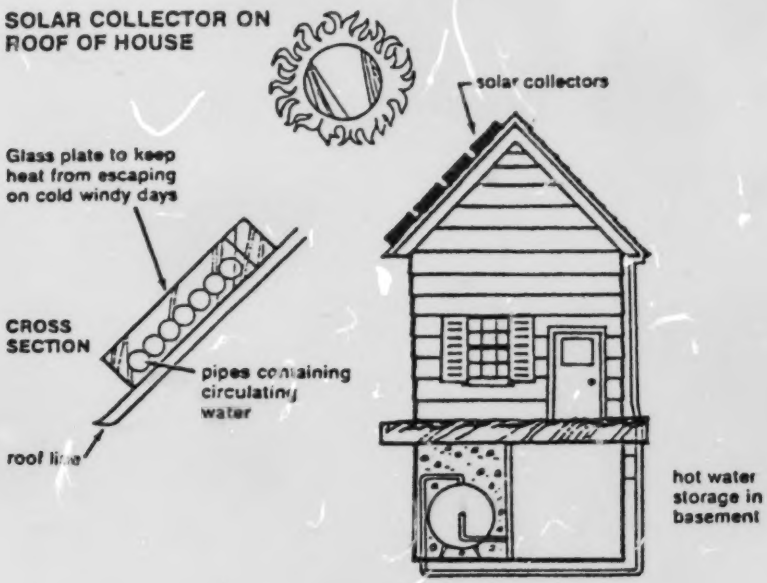
ENERGY FROM THE SUN (Part 1)

There are several ways to use solar (sun) energy. One way is for each house, apartment or office building to collect enough solar energy to take care of its own heating, air conditioning, and water heating, but not its electric power. Another is to build huge solar farms to collect solar energy, turn it into heat and then to electricity that will be sent to individual dwellings. A one-square mile farm of many of these collectors could supply electricity for about 20,000 houses.


SOLAR COLLECTOR ON ROOF OF HOUSE
solar collectors
Glass plate to keep heat from escaping on cold windy days
CROSS SECTION
pipes containing circulating water
roof line
hot water storage in basement

1. What parts of the U.S. would be able to use solar heat without a conventional back-up furnace?

2. What side of the roof should the collectors be mounted on?

3. Why is the inside of some types of collectors lined with mirrors?

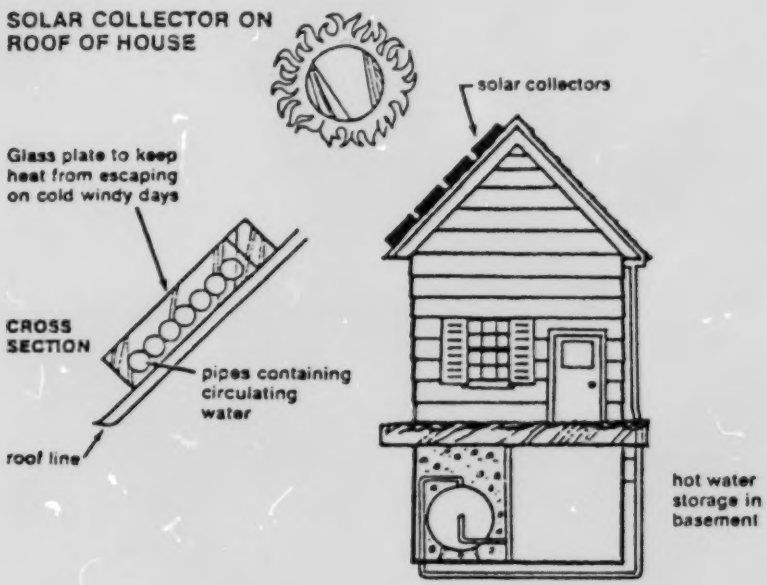
4. Will the heat from roof collectors be used to generate electicity?

5. Could the heat from solar farm collectors be used to generate electricity?

6. The U.S. Energy Research and Development Administration foresees as much as 25 percent of our energy needs filled by solar technologies by the year 2020. Why will it take so long?

ENERGY FROM THE SUN (Part I)

There are several ways to use solar (sun) energy. One way is for each house, apartment or office building to collect enough solar energy to take care of its own heating, air conditioning, and water heating, but not its electric power. Another is to build huge solar farms to collect solar energy, turn it into heat and then to electricity that will be sent to individual dwellings. A one-square mile farm of many of these collectors could supply electricity for about 20,000 houses.


SOLAR COLLECTOR ON ROOF OF HOUSE
solar collectors
Glass plate to keep heat from escaping on cold windy days
CROSS SECTION
pipes containing circulating water
roof line
hot water storage in basement

1. What parts of the U.S. would be able to use solar heat without a conventional back-up furnace?

The South; Southwest

2. What side of the roof should the collectors be mounted on?

the south side

3. Why is the inside of some types of collectors lined with mirrors?

to reflect and concentrate the rays of the sun.

4. Will the heat from roof collectors be used to generate electicity?

no

5. Could the heat from solar farm collectors be used to generate electricity?

yes

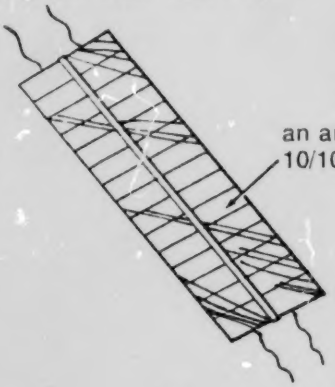
6. The U.S. Energy Research and Development Administration foresees as much as 25 percent of our energy needs filled by solar technologies by the year 2020. Why will it take so long?

technology; cost; setting research priorities

ENERGY FROM THE SUN (Part 2)

SOLAR CELL

This device converts sunlight directly into electricity, with no moving parts and no pollution.


an array of thin silicon cells 10/1000 in. thick
wires lead to electrical batteries which power lights and motor-driven appliances.

1. Solar cell systems are now used to power spaceships and _____ _____.

2. We probably will never run out of silicon as a resource because it is the second most plentiful substance on earth. Do you know its more common name? _____.

3. If it now costs $20 a watt to generate electricity by means of solar cells, how much would you have to spend on equipment to power just the 100 watt light bulbs in your house?_____ _____

4. What do we need to do before we can use solar cells as an energy source? _____

5. How can electricity be stored to use later? _____

THE ADVANTAGES AND THE DISADVANTAGES OF SOLAR ENERGY

Disadvantages

1. Expensive to install
2. Requires a great deal of space
3. The sun doesn't always shine
4. Would mean modification of housing in many cases
5. New laws would be needed concerning construction that might cast shadows

Advantages

(See if you can supply the advantages. What is good about solar energy in regard to each of the following?

1. Supply _____ _____
2. Pollution _____ _____
3. Embargoes _____ _____ _____
4. Cost _____ _____

ENERGY FROM THE SUN (Part 2)

SOLAR CELL

This device converts sunlight directly into electricity, with no moving parts and no pollution.

an array of thin silicon cells 10/1000 in. thick
wires lead to electrical batteries which power lights and motor-driven appliances.

1. Solar cell systems are now used to power spaceships and _____ *satellites*.

2. We probably will never run out of silicon as a resource because it is the second most plentiful substance on earth. Do you know its more common name? *sand*.

3. If it now costs $20 a watt to generate electricity by means of solar cells, how much would you have to spend on equipment to power just the 100 watt light bulbs in your house? _____
# of bulbs x 100 x $20

4. What do we need to do before we can use solar cells as an energy source? *further develop technology and bring down cost*

5. How can electricity be stored to use later? *in storage batteries*

THE ADVANTAGES AND THE DISADVANTAGES OF SOLAR ENERGY

Disadvantages

1. Expensive to install
2. Requires a great deal of space
3. The sun doesn't always shine
4. Would mean modification of housing in many cases
5. New laws would be needed concerning construction that might cast shadows

Advantages

(See if you can supply the advantages. What is good about solar energy in regard to each of the following?

1. Supply *the sun's energy is almost inexhaustible.*
2. Pollution *Solar energy is clean; no mining or burning.*
3. Embargoes *No nation can cut off another nation's supply of sunlight.*
4. Cost *Installations are inexpensive to maintain.*

OTHER NEW ENERGY RESOURCES

Besides nuclear and solar energy, there are several other possibilities for the future. Read about some of these new energy sources in this section. Problems and solutions are associated with each of them. Using page 186, you will decide what some of these problems and solutions are.

WIND. Wind is actually a form of solar energy since it is caused by variations in the temperature of the air heated by the sun that causes air to move. Sailors used this energy for ages. For many years farms have used windmills to generate electricity. Maybe giant windmills will someday be able to provide electricity for entire towns. The major difficulties are that the wind doesn't blow all the time and that practical storage systems are still being developed.

GEOTHERMAL. The earth's center is a molten mass. In some areas this mass is close to the surface. Some evidence of this are volcanos, geysers, and hot springs. This heat can be tapped and used to generate electricity to supply cities without polluting the atmosphere. The problem is that this energy can now be tapped only where it is near the surface. Scientists are searching for other areas where this geothermal energy can be reached, but they don't have all the answers yet.

PYROLYSIS OF SOLID WASTE. It is possible to heat waste in an oxygen-free atmosphere and produce oil and gaseous products. This waste is what we're now having trouble removing from our environment: manure, garbage, paper, logging residue, some industrial waste, sewage, and the like. The difficulty is that this material tends to be scattered in small amounts at various sites. The problem is one of gathering it together at a reasonable cost.

COAL GASIFICATION. By using high temperature and pressure, coal can be converted into a gas very much like natural gas. Building these conversion plants near coal fields can solve the problem of transporting bulky fuel that gives off pollutants when it is burned. When coal gas is burned, it burns as cleanly as natural gas, causing virtually no air pollution. The usual pollution problems occur in the coal mining process, however, as they always have. The conversion process itself, however, uses large amounts of electrical energy.

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COAL LIQUEFACTION. Although the technology is not completely developed, coal can be converted to an oil-like liquid. It has the advantage over coal gas of being usable to make all the usual oil products, including a kind of gasoline to run our cars.

OIL SHALE. Oil shale is a rock containing a material that yields oil when it is crushed and heated. One ton of rock will produce about 25 gallons of oil. Most oil shale deposits are in the West. The rock must be mined, either by deep mining or surface mining. Extracting the oil takes large amounts of water--three barrels to every one barrel of oil processed. One of the big problems is the disposal of the spent rock after the oil is extracted. Vegetation will not grow on the used shale without a moderate amount of rain--scarce in many parts of the West. Without vegetation, some animals may lose their homes and natural food supply. Rain water passing through this rock will possibly pick up pollutants and carry them to larger bodies of water if there is no vegetation. In addition, oil shale processing contributes to air pollution.

Problems/Solutions

In this unit, you have learned about eight new energy resources. The use of any one of these resources may help to supply our energy requirements but may at the same time present us with new problems to consider. In the lefthand column of this page are some of these issues — some are problems, some are solutions. Mark each statement S (for solution) or P (for problem). Place a checkmark in every energy-resource column on the right to which a statement applies. The first one is done for you.

IF THIS ENERGY SOURCE IS USED, IT . . .	SOLAR	NUCLEAR	WIND	GEO-THERMAL	COAL GASI-FICATION	COAL LIQUI-FACTION	OIL SHALE	PYROL YSIS
S WOULD HELP SOLVE THE PROBLEM OF SOLID WASTE DISPOSAL.	✔		✔	✔	✔	✔		✔
_____ COULD POLLUTE WATER.								
_____ WOULD CONSERVE THE DWINDLING RESERVES OF FOSSIL FUELS.								
_____ COULD DAMAGE WILDLIFE OR THEIR HABITAT.								
_____ WOULD BE DIFFICULT TO STORE AND TRANSPORT.								
_____ WOULD NOT POLLUTE THE ATMOSPHERE.								
_____ WOULD DISRUPT THE NATURAL USE OF LAND SURFACES.								
_____ WOULD NOT BE ABLE TO SUPPLY ENERGY ALL THE TIME.								
_____ WOULD HAVE TO WAIT UNTIL THE TECHNOLOGY IS DEVELOPED.								
_____ WOULD USE LOTS OF WATER TO PROCESS.								
_____ WILL DECREASE THE NEED FOR OIL IMPORTS.								
_____ WILL MAKE LARGE AMOUNTS OF WASTE MATERIAL.								
_____ WILL MAKE USE OF THIS COUNTRY'S MOST ABUNDANT FOSSIL FUEL.								

Problems/Solutions

In this unit, you have learned about eight new energy resources. The use of any one of these resources may help to supply our energy requirements but may at the same time present us with new problems to consider. In the lefthand column of this page are some of these issues — some are problems, some are solutions. Mark each statement S (for solution) or P (for problem). Place a checkmark in every energy-resource column on the right to which a statement applies. The first one is done for you.

IF THIS ENERGY SOURCE IS USED, IT . . .	SOLAR	NUCLEAR	WIND	GEO-THERMAL	COAL GASI-FICATION	COAL LIQUI-FACTION	OIL SHALE	PYROL-YSIS
S WOULD HELP SOLVE THE PROBLEM OF SOLID WASTE DISPOSAL.	✓		✓	✓	✓	✓		✓
P COULD POLLUTE WATER.		✓		✓			✓	
S WOULD CONSERVE THE DWINDLING RESERVES OF FOSSIL FUELS.	✓	✓	✓	✓				
P COULD DAMAGE WILDLIFE OR THEIR HABITAT.				✓			✓	
P WOULD BE DIFFICULT TO STORE AND TRANSPORT.	✓		✓					
S WOULD NOT POLLUTE THE ATMOSPHERE.	✓		✓					✓
P WOULD DISRUPT THE NATURAL USE OF LAND SURFACES.		✓		✓	✓	✓	✓	
P WOULD NOT BE ABLE TO SUPPLY ENERGY ALL THE TIME.	✓		✓					
P WOULD HAVE TO WAIT UNTIL THE TECHNOLOGY IS DEVELOPED.	✓		✓	✓	✓	✓		
P WOULD USE LOTS OF WATER TO PROCESS.							✓	
S WILL DECREASE THE NEED FOR OIL IMPORTS.	✓	✓	✓	✓	✓	✓	✓	✓
P WILL MAKE LARGE AMOUNTS OF WASTE MATERIAL.							✓	
S WILL MAKE USE OF THIS COUNTRY'S MOST ABUNDANT FOSSIL FUEL.					✓	✓		

FEA, The Energy Challenge

ENERGY CONSERVATION CHECKLIST

Grade Level 4-12

Purpose: Energy, it's production, use, and conservation are essential in the maintenance of our society as we know it.

Materials: Pencil

Activity: Home Checklist for Energy Conservation

Heating:

___ Set thermostat for heat at 68-70 degrees.
___ Turn thermostat down at least 10 degrees at night.
___ Eliminate use of home air conditioning, if air conditioning must be used, adjust settings so it does not come on below 78-80 degrees.
___ Keep furnace filters clean for more efficient operation.
___ Close fireplace damper when not in use.
___ Open or close drapes to help control indoor temperatures.
___ Do not use oven for heating kitchen.
___ Insulate homes. An uninsulated home requires twice the energy for space heating.
___ Install weather stripping around all windows and doors.
___ Use storm windows, or cover windows with plastic during colder months.
___ Move obstructions away from cold air returns or hot air vents.
___ Thermostats should not be placed on cold walls or outside walls.
___ During the summer all windows that face the sun directly should be shaded.
___ Keep baseboards and heating surfaces clean and unobstructed by furniture or draperies.
___ Minimize the use of portable electric space heaters.
___ Keep humidity as normal as possible (45 percent to 50 percent) by using exhaust fans in high moisture areas.
___ Minimum settings of 55 degrees should be maintained on thermostats when leaving for a period of time; i.e., vacations, moving from the residence, etc.
___ Close foundation vents on the windy side of the house during cold weather.
___ Shut off register and heat vents in unused rooms (check to be sure there are no items in the room vulnerable to freezing).
___ Cover outside section of wall mounted air conditioning units with plastic to prevent air leakage.

Lights and Appliances:

___ Turn off all lights not in use.
___ Reduce bulb wattage where practical
___ Eliminate yard lights. Turn on porch lights only when expecting visitors. Eliminate exterior Christmas lighting.
___ Turn off all unused TV, radio, stereo, etc. . .
___ If you have a choice between color and black and white television use the black and white.
___ Use sunlamps, hair dryers, electric curlers, etc., only when essential.

Laundry:

___ Cut down on use of clothes dryers, hang clothes outside when possible.
___ Dry full loads, but avoid overdrying.
___ Set drying temperature for fabric.
___ Clean lint trap in dryer after every load.
___ Use full loads in washer.
___ Set water level controls to load size.
___ Set water temperature for fabric.
___ Use cold water when appropriate.

Water:

___ Reduce water heater thermostats to 140 degrees.
___ Turn electric water heaters off if you plan to be gone from home more than one day.
___ Take showers when possible, instead of baths; make them brief, and turn faucet only to minimum practical water flow.
___ Use less water for tub baths.
___ Drain and flush your hot water tank at least once a year to prevent build-up of sediments.
___ Repair dripping faucets and leaking toilet fixtures.

Dishwashing:

___ Wash only full loads in dishwasher.
___ Use shortest cycle for load being washed.
___ For hand dishwashing, use a pan of rinse water rather than rinsing under running water.

Cooking and Refrigerating Foods:

___ Preheat oven only when necessary.
___ Choose pans to fit units and cook with lids on pans when possible.
___ Keep oven door closed until food is done.
___ Use pressure cookers.
___ Use self-cleaning ovens as little as possible.

Cooking and Refrigerating Foods (Cont'd):

___ Don't use ovens to heat kitchens.
___ Set refrigerator temperature to maintain 35 to 40 degrees in fresh foods compartments.
___ Defrost refrigerator when frost is 1/4 inch thick.
___ Be sure door seals on refrigerator and freezer are good.
___ Clean condensor coil regularly.
___ Cool foods before refrigerating or freezing.
___ Don't overload refrigerator or freezer.

WATER CONSERVATION

Grade Level 7-12

Purpose: To realize that people use huge amounts of water every day and to appreciate more fully the problems associated with supplying the demand.

Concept: In any environment, one component (water, air, food, space, etc.,) may become a limiting factor.

Materials: Paper and pencil

Activity: Involve students in calculating the amount of water used daily in their homes, community, state and the country. A table such as follows might be useful. Selected individuals or small groups might investigate, through interviews with key personnel, the availability (present and future) of water in the community using survey questions such as those on the next page. Finally, discuss the findings with the entire class to determine what they might mean to individuals, industry, government or other groups.

ESTIMATED WATER CONSUMPTION

Source (Where Used)	Population	Use Factor (Gal/Person/Day)	Estimated Daily Water Use (Gallons)
Home			
City			
State			
United States			
United States (All sources)			

Environmental Education, "John Towler and David Benchley, Environmental Quarterly Magazine, May, 1973, pp. 58-60.

COMMUNITY SURVEY ON WATER NEEDS:

1. Name of person and position (job title).
2. Where does city get it's water?
3. Why is it obtained from this source?
4. Has there ever been a water shortage here? When? Why? How severe?
5. What action was, is, or should be taken during a shortage:
   a. by individuals
   b. by city
   c. by industry
6. Are there any dependable alternate sources for city water supply?
7. What plans have been made to meet future needs?
8. Is the city recycling water?
9. Does the city supply water to any large industries? If so, how many gallons per day?
10. How much water is distributed daily to residential areas? To businesses?
11. What is the present price rate structure for city water?
12. Does price rate differ for homes, businesses, or industries? Is rate dependent upon total amount used?

AMERICAN LIFESTYLES

Grade Level 4-12

Purpose: To become more aware of energy wasteful habits.

Concept: American lifestyles require large amounts of energy.

Materials: Pen or pencil

Activity: There are many ways to conserve energy in and around the home without sacrificing our level of living. When one reduces the amount of energy used, one also saves money for other needs. Check appropriate column:

Have Done	Will Do	
		Personal Care
_____	_____	Minimize hot water use in bathing.
_____	_____	Check to see if less water is used in showering.
_____	_____	Do not leave water running while shaving.
_____	_____	Turn off faucets promptly after use.
		Recreation and Entertainment
_____	_____	Turn off TV, radio, or stereo when not in use.
_____	_____	Disconnect instant-on TV when you are not home.
_____	_____	Use shop or hobby equipment efficiently.
_____	_____	Maintain tools in good operating condition.
_____	_____	Spend vacations closer to home.
_____	_____	Develop leisure activities, such as bicycling, hiking, reading, swimming.
		The Family Automobile
_____	_____	Drive at moderate speed and not more than the 55 mph speed limit.
_____	_____	Don't warm up the car for more than a minute or two.

		The Family Automobile (Cont'd)
_____	_____	Provide proper maintenance; make sure you have a well-tuned engine and properly inflated tires.
_____	_____	Combine errands by careful planning.
_____	_____	Carpool whenever possible.
		Cooking and Baking
_____	_____	Use oven to capacity.
_____	_____	Use cooking utensils which fit the electric unit or gas burner.
_____	_____	Use tight-fitting lids on cooking utensils when appropriate.
_____	_____	Reduce heat to maintain necessary cooking temperature when using surface units or burners.
_____	_____	Use small appliances for cooking, baking, and toasting if they are more efficient than the range.
_____	_____	Preheat oven only when necessary. Do not preheat longer than needed to attain required temperature.
_____	_____	Turn off oven, surface units, or burners promptly when food is cooked.
		Laundry
_____	_____	Wash only full loads of laundry.
_____	_____	Use heated water only in the wash cycle.
_____	_____	Use water no hotter than necessary for adequate soil removal and sanitation.
_____	_____	Use good laundry techniques to obtain satisfactory results in one washing process.
_____	_____	Avoid over-drying in the dryer.

			Laundry (Cont'd)
____	____	_____	Line dry garments and household items when practical.
_____	_____		Use the dryer efficiently. Avoid drying one or two items at one time.
_____	_____		Remove items when dryer stops to avoid unnecessary wrinkling which will require pressing to remove.
_____	_____		Reduce ironing to a minimum by careful selection of garments and household linens.

OPINION POLL: WHAT DO YOU THINK?

Grade Level 6-12

Purpose: This activity is designed to give the student a "feel" for the energy situation. It is intended to be a quick, broad view of the energy spectrum and not an in-depth examination. Students should be encouraged to participate in this written exercise without fear of a formal test mark being applied.

This is a process where data can be assembled for discussion of research activities and where the teacher can accurately assess the level of awareness and state of knowledge of the students concerning the energy problem.

It is suggested that you have diagrams of possible answers prepared beforehand so that you can readily compile the poll results and go over them with your students, either on the first day or the next. This layout can be on paper, on the chalkboard, or on the overhead projector.

In addition, the opinion poll portion could serve as a survey instrument for your students to use in conjunction with Energy Awareness Week. Different sectors of the community (e.g., housewives, teachers) could be interviewed. The different opinions expressed could provide some interesting information.

ENERGY OPINION POLL

Directions: The following is not intended to be a test, but rather a poll to determine your opinions and feelings about the current energy situation.

I. The following issues have received substantial attention during recent years. Please rank these issues in the order of their importance to you by placing a "1" next to the most important issue, a "2" next to the second most important issue, and so on.

___ Corruption in government
___ The energy crisis
___ Inflation in the United States
___ Middle East tensions
___ Environmental pollution problems
___ The drug abuse problem
___ Organized crime
___ Moral decay
___ Unemployment
___ Racial tensions
___ Other; please specify_____

II. What do you feel are the most urgent environmental concerns? (Please rank the major categories by number in order of priority.)

___ Population problems
___ Transportation problems
___ Energy problems
___ Resource depletion
___ Natural environment
___ Aesthetics
___ Materialism
___ Planning, design, and construction problems
___ Economic-social-cultural problems
___ Knowledge gaps
___ Health hazards
___ Water problems
___ Land use problems
___ Air problems
___ Other(s); please specify_____

III. Listed on the following pages are a number of statements relating to environmental issues and the energy crisis. Please indicate whether you agree or disagree with these statements by placing a check (✓) in the appropriate blank.

For example: If you strongly believe that everyone talks about the energy crisis but no one does anything about it, you would check (✓) "strongly agree" as shown below:

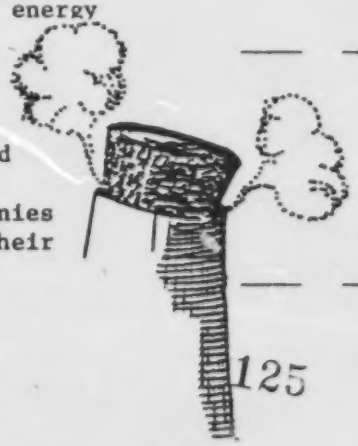
	Strongly Disagree	Slightly Disagree	Neutral	Slightly Agree	Strongly Agree
Ex. Everyone talks about the energy crisis; no one does anything about it.	___	___	___	___	✓
1. It is more important to solve the inflationary crisis than to solve the energy crisis.	___	___	___	___	___
2. The energy crisis is a pressing national problem which demands real sacrifices on the part of all citizens.	___	___	___	___	___
3. New automobile engines have been produced which significantly increase gasoline mileage.	___	___	___	___	___
4. Oil companies that advertise their efforts to develop new energy sources are more concerned with public relations than resource development.	___	___	___	___	___
5. Although mass transit would be a good way to conserve energy, it is rarely used because it seldom meets the needs of potential users.	___	___	___	___	___

	Strongly Disagree	Slightly Disagree	Neutral	Slightly Agree	Strongly Agree
6. We should continue to support the Israeli position in the Middle East despite the energy problems caused by Arab oil embargo of 1973.	___	___	___	___	___
7. Because of the abundance of coal, industries should be encouraged to switch to coal as a fuel despite the air pollution it causes.	___	___	___	___	___
8. One benefit associated with the energy crisis will be a reduction in air pollution due to fewer automobiles on the road.	___	___	___	___	___
9. The reduction of air pollution is more important than energy conservation.	___	___	___	___	___
10. The energy crisis should be viewed as beneficial since it will reduce auto travel as well as the accident rate.	___	___	___	___	___
11. Gasoline rationing would be an unnecessary hardship on our citizens.	___	___	___	___	___
12. Rationing of energy resources (i.e., gasoline) will be necessary in the very near future.	___	___	___	___	___
13. Our traditional energy resources (coal, oil, natural gas, etc.) are insufficient to continue energy consumption at the present rate.	___	___	___	___	___

	Strongly Disagree	Slightly Disagree	Neutral	Slightly Agree	Strongly Agree
14. The 55 m.p.h. speed limit on federal highways has been effective in reducing vehicle speeds.	___	___	___	___	___
15. Most of our environmental problems come from the misuse of energy.	___	___	___	___	___
16. People should include as many stores as possible in a shopping trip.	___	___	___	___	___
17. It is useless for me to take energy conservation measures seriously since my contribution won't make that much difference.	___	___	___	___	___
18. Since every man is a consumer, it is the consumer sector that is responsible for the energy crisis and not the government or the oil companies.	___	___	___	___	___
19. Because of the energy shortage, no television or radio programming should be permitted after 10:00 in the evening.	___	___	___	___	___
20. It should be illegal to keep one's house warmer than 68^{o} in the winter.	___	___	___	___	___
21. Automobile engines that operate on fuels other than gasoline will be used in the future to conserve petroleum resources.	___	___	___	___	___

	Strongly Disagree	Slightly Disagree	Neutral	Slightly Agree	Strongly Agree
22. Trucking companies are doing their fair share to reduce fuel consumption by observing the 55 m.p.h. speed limit on federal highways.	___	___	___	___	___
23. Increased energy costs (i.e., gasoline and electricity) have reduced the amount of money that people have left after paying for necessities.	___	___	___	___	___
24. Gasoline stations are making unreasonably high profits.	___	___	___	___	___
25. Gas stations provide the same level of services now as they did before the energy crisis.	___	___	___	___	___
26. Airlines should continue to reduce the number of flights available in order to conserve fuel.	___	___	___	___	___
27. I make about the same number of shopping trips now as I did a year ago.	___	___	___	___	___
28. Due to the recent introduction of anti-pollution devices on new cars, cars are no longer a serious source of air pollution.	___	___	___	___	___

	Strongly Disagree	Slightly Disagree	Neutral	Slightly Agree	Strongly Agree
29. There should be more car pooling in order to significantly reduce gasoline consumption.	___	___	___	___	___
30. Since the price of gasoline has risen significantly, people have cut down on their driving.	___	___	___	___	___
31. Lower speed limits (55 m.p.h.) on federal highways have significantly reduced gasoline consumption.	___	___	___	___	___
32. People with air conditioning should voluntarily keep the temperatures of their homes at 76° or above during summer months.	___	___	___	___	___
33. The energy shortage has made our highways less crowded.	___	___	___	___	___
34. The worst of the energy crisis has passed.	___	___	___	___	___
35. Technological advances will produce a solution to the energy crisis.	___	___	___	___	___
36. The government should impose rigid controls to force companies to reduce their pollution.	___	___	___	___	___



	Strongly Disagree	Slightly Disagree	Neutral	Slightly Agree	Strongly Agree
37. The energy crisis did not greatly affect my vacation plans this year.	___	___	___	___	___
38. Oil companies should be forced to lower their prices.	___	___	___	___	___
39. In the winter months, oil companies should reduce gasoline production in order to assure an adequate supply of heating oil.	___	___	___	___	___
40. The government should impose rigid restrictions to make the individual citizen reduce his energy consumption.	___	___	___	___	___

IV. This section examines your opinion about different aspects of the energy crisis. There are no right or wrong answers to these situations; your response represents your opinion. (Please check (✓) the single blank in each row that best indicates your position.

For example: If you thought that the energy crisis could be described as "slightly decreasing," you would check (✓) the scale as shown below:

	Extremely	Slightly	Neither	Slightly	Extremely	
Increasing	___	___	___	✓	___	Decreasing

I believe the energy crisis is:

	Extremely	Slightly	Neither	Slightly	Extremely	
True	_____	_____	_____	_____	_____	False
Changeable	_____	_____	_____	_____	_____	Stable
Interesting	_____	_____	_____	_____	_____	Boring
Concealed	_____	_____	_____	_____	_____	Revealed
Optimistic	_____	_____	_____	_____	_____	Pessimistic
Safe	_____	_____	_____	_____	_____	Dangerous
Dishonest	_____	_____	_____	_____	_____	Honest
Unimportant	_____	_____	_____	_____	_____	Important
Old	_____	_____	_____	_____	_____	New
Relaxed	_____	_____	_____	_____	_____	Tense

V. Without referring elsewhere, define the term "energy" in your own words:

VI. Please circle the letter of your opinion for each question in this section.

1. What is your opinion about the energy shortage; do you think it is a temporary or short-range problem which will go away quickly, a problem which will exist for only a few years, or do you think it is a long-range problem with which we will have to deal for some time to come?

   (a) a temporary problem; (b) a problem that will exist for a few years; (c) a long-range problem

2. Which of the following do you feel has contributed the most toward the current energy shortage?

   (a) industry; (b) government; (c) individuals

3. How good a job do you think business and industry have done in combatting the energy crisis?

   (a) excellent; (b) good; (c) fair; (d) poor

4. How good a job has the average citizen done in cooperating to reduce his energy consumption?

   (a) excellent; (b) good; (c) fair; (d) poor

5. Do you think that the government has done enough, too much, or too little in regulating industry and business to reduce energy consumption?

   (a) enough; (b) too much; (c) too little

6. All things considered, do you think citizens will, on their own initiative, further reduce energy consumption or do you think the government will have to force them to do so?

   (a) will do so on their own initiative; (b) government will have to force them to do so

7. In your opinion, should any government agency take on the responsibility to regulate energy consumption?

   (a) yes; (b) no

8. At what level should the primary responsibility for overseeing energy usage and establishing guidelines be, providing that such government actions are found necessary?

   (a) federal; (b) state; (c) local

9. If regulations for energy consumption should become necessary, which of the following sectors should be regulated?

   (a) industrial; (b) commercial; (c) residential, (d) transportation (residential); (e) transportation (commercial)

10. In your opinion, would it be acceptable to reduce consumption of energy by letting the price of energy go up so high that consumption will never exceed energy supplies?

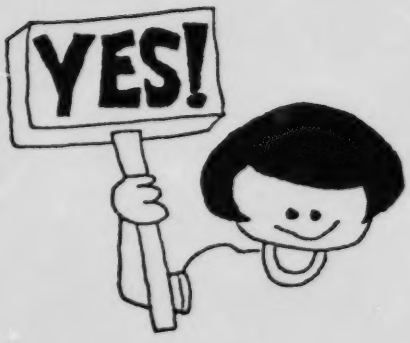
    (a) yes; (b) no

VII. Have you done anything to help relieve energy shortages? If so, describe below. (For example, "used less lighting at home.")

VIII. Refer below to the "What I Personally Believe/Do Not Believe" chart. List all those things you have heard, read, or have been told regarding the energy situation under the appropriate heading. Once listed, research each statement to gather data supporting your "belief." Record any changes of your "beliefs."

THE ENERGY SITUATION

WHAT I PERSONALLY BELIEVE	WHAT I PERSONALLY DO NOT BELIEVE
Example: Energy costs more than it used to.	There's lots of oil under the Smoky Mountains.



ENERGY POTPOURRI

Grade Level 4-12

Purpose: To keep students aware of current developments in energy sources, use and conservation.

Activity: The students will collect newspaper and magazine articles on energy.

Have the students prepare:

1. Energy conservation scrapbooks, containing articles, reports written by the student, pictures cut from magazines or newspapers, pictures taken by the student, cartoons, poems found or written by the student, etc. On the secondary level, students can be asked to collect articles and prepare scrapbooks on a certain topic such as saving electricity, conserving gasoline, coal gasification, nuclear power, etc., and give reports to the entire class.

2. Make collages from the articles and pictures. Prepare one with a positive outlook and one with a negative outlook.

3. Prepare bulletin boards for their own and other classrooms, either arranged around a certain topic such as conservation of gasoline, obtaining coal from the earth, nuclear power, etc., or a collage-type display.

4. Hold discussion groups centered on certain articles and editorials.

5. Stage a debate on both sides of a selected editorial.

6. Discuss vocabulary from articles (primarily energy-related words)

7. Conduct "college bowl" or "bee" types of quizzes involving the whole class and centered on energy.

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

ENERGY QUIZ

Grade Level 4-12

Purpose: This is not meant as a comprehensive test on energy terms and facts, but as a sample which should be extended by the teacher. The purpose is not testing the student, but presenting facts and definitions about energy in an interesting manner. Each question should have a definite learning objective in mind, answers follow the questions.

True or False

___ 1. Energy conservation can be thought of as a new source of energy.

___ 2. The U.S. has most of the world's petroleum reserves.

___ 3. Solar energy shows little promise for helping us satisfy our energy needs.

___ 4. The recent growth in U.S. energy use has been supported by importing fuels from other countries.

___ 5. Satisfying our growing energy needs must create more pollution.

Circle the Best Answer

6. Modern automobiles waste about_____of the energy potential in gasoline.

   (a) 25 percent (c) 65 percent
   (b) 40 percent (d) 80 percent

7. The U.S. uses about_____of the work energy output each year.

   (a) 10 percent (c) 50 percent
   (b) 35 percent (d) 81 percent

8. The price of a barrel of crude oil increased from $1.80 in 1970 to_____in January 1974.

   (a) $2.50 (c) $11.65
   (b) $5.07 (d) $14.25

9. Which is the biggest energy user in the U.S.?

   (a) Commercial (c) Residential
   (b) Industrial (d) Transportation

10. What is the biggest energy consumer in the home?

(a) heating
(b) lighting
(c) air conditioning
(d) cooking

11. How much of the energy stored in coal burned in a power plant can be delivered to the customer's home as electricity?

(a) 1/3
(b) 1/2
(c) 2/3
(d) all of it

12. Which of the following fossil fuels is in greatest danger of exhaustion?

(a) gas (b) oil (c) coal

13. Which of the following fossil fuels is in heaviest use presently?

(a) gas (b) oil (c) coal

14. Who said, "A major factor contributing to our present energy crisis is that the necessary research and development efforts which could have provided us with the technological options and capabilities we now need so desperately were not undertaken in the past."?

(a) Gerald Ford
(b) Ralph Nader
(c) Hubert Humphrey
(d) Henry Jackson

15. Americans use_____times as much energy per capita than the rest of the world.

(a) 2
(b) 4
(c) 9
(d) 20

16. Otner than in nuclear reactors the ultimate source of all energy is_____

17. Which uses more energy--an electric razor or a straight razor?

18. Which uses more energy--washing dishes by hand or in an electric dishwasher?

19. Unless major technological changes occur by the year 2000, our greatest source of energy in useable form will be

(a) natural gas
(b) petroleum
(c) coal
(d) solar
(e) nuclear

20. At current rates by the year 2000, our energy use will increase by

(a) 25 percent
(b) 50 percent
(c) 100 percent
(d) More than 100 percent

Answers:

(1) T (2) F (3) F (4) T (5) F (6) d (7) b (8) c
(9) b (10) a (11) a (12) a (13) b (14) d (15) c
(16) the sun (17) straight razor (because of hot water heater)
(18) washing dishes by hand (19) c (20) d

ROLEPLAYING

Grade Level 4-12

Objective: To yield an understanding of the importance for recognizing other people's points of view concerning the energy shortage.

Activity: A. Family Roles

The students may be divided into groups to roleplay family situations which require reaching decisions based on energy conservations such as:

Should the family go on a vacation or buy a new car?
Should the child go to camp or buy a 10-speed bike?
Should Mr. Jones buy his wife a dishwasher or dryer for her birthday?
How can the family conserve energy?
How can the family eliminate unnecessary car trips?

B. Community Roles

Select a community problem or possible problem, such as a gasoline shortage, a raise in electricity rates, a coal miners' or truckers' strike, rationing of heating oil, etc. Problem-solving situations also may be proposed, such as setting up a gas rationing system, eliminating pollution problems, a price-wage freeze, etc. Select students to play the following roles:

1. The owner of a trucking company
2. A government official
3. A farmer
4. A businessman
5. A housewife
6. A forester
7. A conservationist
8. A coal miner
9. An oil company executive
10. A private citizen
11. A student
12. "Old Mother Earth"

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

C. National Roles

Set up problems on a national and international basis, such as an Arab oil embargo, war in the Middle East, threatening bankruptcy of an European nation because of the energy situation, threatened takeover of the U.S. stock market by the Arabs, etc.

Possible roles are:

1. A U.S. citizen
2. A U.S. Congressman
3. Secretary General of the U.N.
4. An Arab leader
5. British prime minister
6. Leaders of the U.S., Russia, and Red China
7. Leader of a small country whose energy consumption is only 1/20th of that of the U.S.

Some research and discussion may be necessary before students can play some of the above roles.

Extended Activities:

1. Set up a learning center with headphones and tape recordings of situations. Have the students decide independently.

2. Arrange a bulletin board display situation. "What would you do?" could be the caption.

3. Simulate a case in front of the "World Court," where a child from an underdeveloped nation has sued a child from the U.S. to obtain his share of the world's energy. Possible roles are:

   The judge
   2 lawyers
   5-man jury
   defendant (child from U.S.)
   complainant or plaintiff (child from underdeveloped country)
   witnesses--possibilities:
   U.N. representative from the U.S. Dept. of Health
   mothers of the 2 children
   leaders of the 2 countries, etc.

4. Include a discussion of the natural resources used in providing the American child with energy.

RECREATION ENERGY

Grade Level 4-12

Purpose: To sense relationships between recreational activities and energy usage.

Concept: Natural resources affect and are affected by the material welfare of a culture and directly or indirectly by philosophy, religion, government and the arts.

Reference: Energy and Man's Environment. Elementary Through Secondary Interdisciplinary Activity Guide, Education/Research Systems, Inc., 2121 Fifth Avenue, Seattle, Washington 98121.

Activity: Ask the students to work in groups of three and develop a chart in which they (1) list all of the common recreational activities they can think of, (2) name the kinds of energy needed to engage in each recreational activity, (3) judge the extent to which each activity is healthful or harmful, (4) estimate how popular each recreational activity is in their community, state and nation, and (5) the extent of their personal interest in each activity. Ask each group to be creative in designing the chart or table so it can include easily all of the judgements requested.

Summarize the material developed by the small groups in a large matrix on the chalkboard, or large sheet of paper, and discuss the results.

Do spectator sports such as football require much energy? What kind? How would they rate a major sporting event such as the Indianapolis 500-Mile Auto Race? How would they compare with vacationing in a mobile home? What is their judgement about the desirability of sporting arenas such as the Astrodome?

Is the general pattern of recreational activity in America geared to high energy use? If so, what can and/or should be done about it?

ERIC/SMEAC, Teaching Activities in Environmental Education.

APPLIANCE QUESTIONS

Grade Level 4-12

Purpose: To understand the relationships between use of appliances and energy consumption.

Activity:

1. Find out what features on appliances consume extra energy. Debate benefits of each feature versus added operating costs and energy consumption.

2. If the cost of electricity increased so much that you had to reduce your consumption, which major appliance would you cut out first? (Major appliance list: refrigerator, electric range, color TV, freezer, room air conditioning unit, clothes washer, electric clothes dryer, and dishwasher).

3. What considerations should be made when members of your family purchase major electric appliances? What influences their selection of brand, size, and model? Do they consider the amount of electricity required? Should they (or you)?

4. Some experts advise the public not to purchase color television sets. Their advice is based on a variety of reasons ranging from higher initial cost to greater danger of radiation. Should people buy only black and white, solid state TV sets? Why? If you were going to purchase a TV set, what type would you buy? How would the energy situation affect your decision?

5. One of the most vocal suggestions to reduce electric energy use has been to eliminate outdoor advertising and lighting. Some persons have criticized the use of Christmas decorative lighting as wasteful. What about the consumer in his home setting? Until laws are passed that dictate otherwise, it remains the responsibility of each individual to conserve on electrical usage. Check the statement following which best describes your feelings about this complex situation:

___The homeowner should have unlimited use of his Christmas decorations.

___The homeowner should be allowed to use whatever decorations he desires in his home, but should not be permitted to put up any exterior decorations which require use of electricity.

A Teacher's Guide for Energy Conservation, Environmental Center, University of Tennessee, Knoxville, Tennessee.

____In view of the energy problem, all interior and exterior decorations that require power should be prohibited.

____Other (Please specify)_____

_____

HOW MUCH DO YOU KNOW ABOUT APPLIANCES?

Place the correct answer in the space beside each question.

_____ 1. How many appliances--ranging from the pocket transistor radio to the 15 cubic foot freezer--do you estimate there are in the U.S. today? (200 million; 800 million; one billion; one trillion)

_____ 2. The combined usage of all appliances accounts for what percentage of the total U.S. energy consumed? (5%; 10%; 18%; 25%)

_____ 3. a. From the major appliances on the right, select the one that requires the most wattage to operate.

b. Now select the appliance which is the most expensive to operate on an annual basis.

Refrigerator
Electric range
Color television set
Room air conditioner
Electric clothes dryer
Automatic clothes washer
Freezer
Dishwasher
Portable heater (approx. 1322 watts)

_____ 4. Which type of lighting is more efficient and costs less to operate--fluorescent or incandescent?

_____ 5. The mineral deposits accumulating on the bottom of your water heater interfere with the transfer of ____ to the water.

_____ 6. The size of an appliance does not necessarily give you any idea of how much energy it uses. (True or False)

_____ 7. The oven should not be used to heat the kitchen. (True or False)

_____ 8. Generally, less water is used to take a bath than a shower. (True or False)

_____ 9. A freezer operates more efficiently when it is three-quarters full than when it is one-quarter full (True or False)

_____ 10. Next to your range, the hot water heater has the highest average wattage requirement of all your appliances. (True or False)

_____

A Teacher's Guide for Energy Conservation, Environmental Center, University of Tennessee, Knoxville, Tennessee.

_____11. Solid state devices on color television sets consume much less energy than tube type devices. (True or False)

_____12. An appliance's lifetime energy consumption can amount to many times its initial cost. (True or False)

SAMPLE TEST FOR APPLIANCE SECTION

Grade Level 4-12

Purpose: To gain knowledge on appliance use

Activity: Testing

Preliminary piloting indicated that some teachers wanted to administer this test both before and after the section in order to judge improvement. Use of the test is, of course, optional in either case. Test questions are on the following page.

Answers

1. one billion
2. 5 percent
3. a. Electric range
   b. Refrigerator
4. Fluorescent
5. Heat
6. True
7. True
8. False
9. True
10. False (Correct answer is the electric clothes dryer)
11. True
12. True

A Teacher's Guide for Energy Conservation, Environmental Center, University of Tennessee, Knoxville, Tennessee.

ELECTRICAL POWER USAGE CHART

Appliance	Average Watts
Blanket	190
Bottle Warmer	500
Broiler	1400
Can Opener	10
Carving Knife	95
Clock	2
Clothes Dryer	4600
Coffee Maker	800
Corn Popper	525
Dehumidifier	260
*Dishwasher	1200
Egg Cooker	500
Fans	
Attic	370
Circulating	90
Kitchen	250
Roll-about	170
Window	200
Floor Polisher	350
Food Blender	350
Food Freezer--15 cu. ft.	
Standard	350
Frost Free	440
Food Mixer	125
Food Warming Tray	350
Food Waste Disposer	450
Fry Pan	1150
Fryer, Deep Fat	1500
Furnace (varies considerably with area, degree days and family living habits)	
Oil	500
Gas	500
Germicidal Lamp	20
Griddle	1450
Grill, Sandwich	1160
Hair Curler	1100
Hair Dryer	400-2000
Heat Lamp	250
Heater	
Portable	1270
Radiant	65
Heating Pad	1250
Hot Plate	1250
Iron	1100
Ironer	1500
Lamps	
Incandescent	10 up
Fluorescent	15-60
Lawnmower	1000
Motors	
1/4	200-400
1/2	450-600
Over 1/hp.per hp	950-1100
Night Light	10
Post Light (Photo Cell)	100
Projector	
Slide	500
Motion Picture	700
Radio	
Console	75
Table	50
Radio-phonograph	110
Range	12000
Self-Cleaning Oven	4000
Razor	15
Record Player	
Console	160
Table	75
Recorder	100
Refrigerator--12 cu. ft.	
Standard	240
Frost Free	320
Refrigerator-Freezer--14 cu. ft.	
Standard	325
Frost Free	360
Roaster	1320
Rotisserie	1400
Sewing Machine	100
Sun Lamp	300
Television	
Black & White	240
Color	350
Toaster	1150
Toothbrush	5
Vacuum Cleaner	
Portable	210
Standard	600
Vibrator	40
Waffle Iron	1100
*Washer	
Automatic	500
Nonautomatic	285
Water Heater (varies considerably with clothes washing and bathing habits	

*Does not include electricity to heat water

ELECTRICAL ENERGY NEEDS

Grade Level 4-10

Purpose: To relate electrical energy needs to maintenance of present life styles.

Concept: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

Reference: Activity suggested by M.K. Waggoner, Science Teacher, Fairland High School, Proctorville, Ohio.

Activity: (It will be evident that this activity works best just prior to a five or more day vacation when the student is not required to be in school or other public institution.)

On the school day prior to the beginning of this activity ask each student to survey his/her home and property after school and list every item that requires alternating current in order to function.

On the first day of this activity make a composite list on the classroom blackboard of all the types of items named by the students.

Divide the students into small groups of 3-5 and have each group use the composite list to make the following sublists:

1. Items "absolutely necessary"
2. Items "difficult to do without"
3. Items "you could live without"
4. Items "that are nice to have"
5. Items "entirely luxurious"

Student groups will differ somewhat on where they sublist various items and these differences should be discussed to help them see their own hierarchies of needs.

On the classroom blackboard, divide the items in the composite list into the five sublists based on general concensus of the class. Be sure each student now has these items so listed.

Now ask for student volunteers who will take part in the following experiment during their impending five

(or more) day vacation. Volunteers will eliminate from their daily lives as many items as practicable according to the following form:

Day 1. Eliminate all items in sublist 5;

Day 2. Eliminate all items in sublists 5 and 4;

Day 3. Eliminate all items in sublists 5, 4, and 3;

Day 4. Eliminate all items in sublists 5, 4, 3, and 2;

Day 5. Eliminate all items in sublists 5, 4, 3, 2, and 1.

Ask students to keep daily diaries during the course of the experiment of their impressions and discuss these as a group when school resumes.

Discussion should help students see what changes, if any, they would willingly make in their life styles to conserve energy; what changes may be reasonably imposed on them during an energy shortage and what they would consider unreasonable hardships during such a shortage. This discussion may also lead into another activity on alternate energy sources, should the students not desire any reduction in energy consumption.

SCHOOL SURVEY OF ENERGY-USING APPLIANCES

Grade Level 4-12

Purpose: To create awareness of energy-using appliances in the school.

Activity:

1. Make a list of all energy-using appliances in the school.

2. Separate the list into essential and non-essential items.

3. By vote, select a non-essential item for your class to do without for a week.

   Have each student report on their lists, and give another report after the week's trial.

Extended Activities:

1. Have students draw a floor plan of the school, locating all of the electrical outlets on the diagram. They also could mark which outlets were in use at different intervals.

2. Have a demonstration to show the time and convenience gained by using a modern electrical appliance versus its mechanical counterpart. For example, an electric knife vs. a dinner knife, electric scissors vs. mechanical scissors, hand mixer vs. an egg beater, electric can opener vs. a mechanical can opener.

   Do you feel the time and convenience gained is worth the additional cost and energy consumed in every case?

3. Have students list advantages and disadvantages of various electrical appliances. Let each student draw a model "appliance" which can do the same task but uses either coal or oil rather than electricity.

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

ALASKA PRIORITIES

Grade Level 4-12

Purpose: To recognize our dependence on appliances.

Materials: Pencil

Activity:

Jim and Pat Kelly are building a cabin in wilderness area in Alaska. They will have no electricity (even though it is available in a nearby town where Mr. Kelly works), but that's the way they want it. They have some strong convictions about living simply. But, there are few people like the Kellys. Many people cannot imagine life without electricity. They consider it absolutely essential to a continued high quality of life. How do you feel about the use of electricity? Place a check in the column which best describes your attitude toward doing without each of the following electrical items:

	Very Easily	Easily	With some Difficulty	With great Difficulty	Impossible
Radio					
Stereo					
Air conditioning at home					
Air conditioning at work/school					
Dishwasher					
Clothes washer					
Iron					
electric stove					
Refrigerator					
Lights					
Central heating					
Doorbell					
Ice crusher					
Toaster					
Hair dryer					
Television					
electric fans					
Clocks					
Vacuum cleaner					
Microwave oven					
Freezer					
Blender					
Electric blanket					
Electric typewriter					
Thermostatic controlled furnace					
Electric can opener					
Telephone					
Electric toothbrush					
Electric frying pan					
Water heater					
Garbage disposal					
Trash compactor					
Power tools					

ENERGY HABITS GAME

Grade Level 4-12

Purpose: To emphasize good (+) and bad (-) energy habits.

Concept: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

Reference: Environmental Education: Strategies for Wise Use of Energy, North Carolina State Department of Public Instruction, Raleigh, North Carolina.

Activity:

Through this simple board game, students will become aware of efficient energy-usage.

1. Make a game board for every four students.
2. Obtain dice and make place markers for each team.
3. Make positive and negative cards for energy-usage actions. Positive cards indicate efficient practices and negative cards indicate wasteful practices.
4. Roll the dice and move the number of spaces you roll. If a message is on the square, do what it indicates.
5. The winner is the person who gets to the land of Energy-Wise first.
6. After game, discuss how people have different values and attitudes toward energy and the environment.

Energy Cards:

Sample cards: Forward (+); Backward (-)

Energy Cards - Group A: Answer yes - move forward
Answer no - stay where you are

+2 if you turned off the light
+4 if you walked to school or rode your bike
+1 if you took a shower instead of a bath
+1 if you closed the refrigerator door
+3 if your family owns a small 4-cylinder car
+2 if your thermostat is set at 68^{o} or lower to heat
+4 if your family has no air conditioning
+2 if you use fluorescent tubes instead of incandescent bulbs

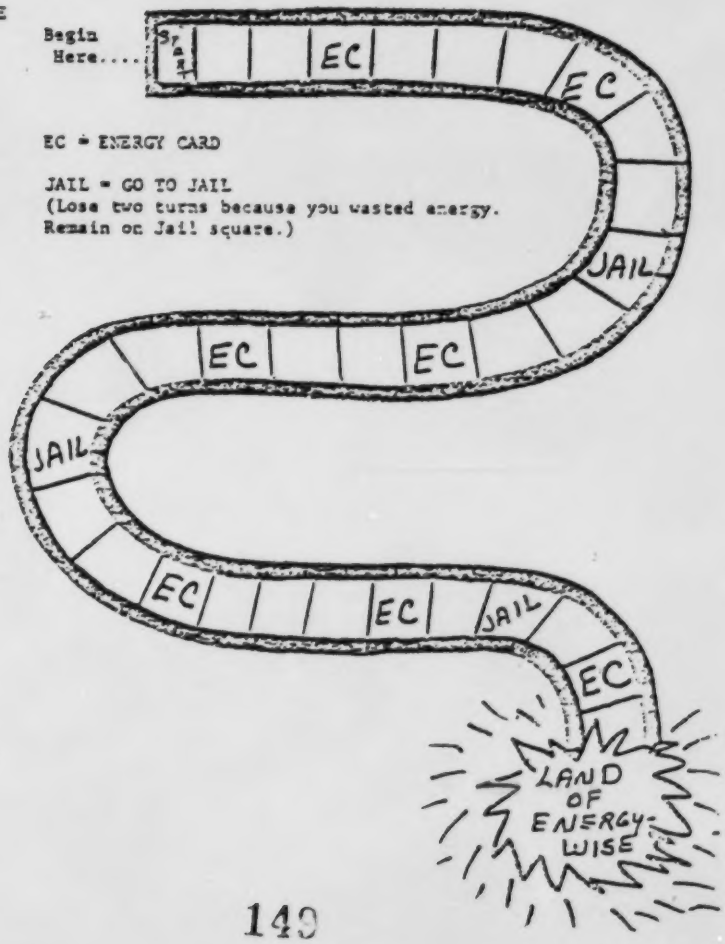
---

+3 if your family has only black and white TV
+1 if you turn off the radio when you leave the room

Energy Cards - Group B: Answer yes - move backward
Answer no - stay where you are

-3 if you use an electric toothbrush
-2 if you use an electric blanket
-4 if your house has no storm windows or storm doors
-3 if you have a dripping hot water faucet at home
-4 if your family has a big car
-4 if your family has a color TV with instant-on
-2 if you have a self-cleaning oven at home
-1 if you have an electric knife in use
-1 if there's an outside light burning during the day at home
-4 if you leave the TV playing when you leave the room

SAMPLE GAME BOARD:



EC = ENERGY CARD

JAIL = GO TO JAIL
(Lose two turns because you wasted energy. Remain on Jail square.)

MAKE-BELIEVE TRIP

Grade Level 4-12

Purpose: How to conserve energy and save money while planning a make-believe trip to Disneyland.

Activity:

Students will go through all the formalities of planning a pretend trip to Disneyland. Begin with a general outline of information needed. For example: How many days will the trip last? How will the class travel? How will the class earn the money to go? What will we do when the class arrives? When is the departure date?

Dividing into committees would be very helpful, or assigning individuals to do research on: (with older groups let them as groups be responsible for much of their own organization)

1. Which way is the most economical way to travel--plane, train, bus, or car? Which way will best conserve energy and time?

2. Plan a budget including gas, food, lodging and miscellaneous items.

3. Plan menus for the trip. How can we save money? How many calories? Are they balanced meals?

4. Plan trip itinerary from beginning to end. Which states? What are the best routes? Which would save gasoline? Which route is the most scenic?

5. Make lodging arrangements. Which is the less expensive? Which is at the best location? Would camping be a possibility?

6. Who will chaperone? Will a nurse be necessary? What are health qualifications for the trip?

7. Set up a correspondence committee to write to travel bureaus and automobile clubs for information. Write to states for information, Disneyland for costs, etc.

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

8. What kind of equipment is needed? Luggage? What do students take for personal needs?

9. Plan the actual visit in Disneyland, including the time schedule. How much money is needed for the day's activities?

Extended Activities:

1. A field trip to a travel bureau, airport, train station, or bus terminal could be planned. A good experience would be to plan a field trip and then actually take the students.

2. Invite a dietician, a travel agent or perhaps someone who has taken a similar trip to talk with the class.

3. Plan a camping trip for the weekend. Follow similar procedures as above, with an emphasis on the best way to travel, eat, and camp in such a manner as to conserve energy and protect the environment.

MEDIA PRESENTATION

Grade Level 8-12

Purpose: Develop a media presentation dealing with energy awareness.

Concept: The learner will develop an awareness of the earth's finite resources.

Materials: Camera, film, apparatus for slide preparation.

Activity: Procedure--

1. Decide on topic
2. Write script
3. Perform activity
4. Select slides
5. Prepare video
6. Prepare audio
7. Edit

Topic Suggestions--

1. Energy Waste in our City
2. Energy: America as the World
3. Future Energy Sources
4. Our Energy Source
5. Energy Audit

Suggest that small groups of students could research different aspects of energy use to formulate a media presentation, slides, super 8, 16 mm, etc., for classroom and community use.

VOCABULARY BLOCK

Grade Level 7-12

Purpose: To reinforce vocabulary applicable to energy unit through use of word search puzzle.

Concept: Recognition of terminology is essential to understanding information presented.

Activity:

The block below contains at least 60 words applicable to the energy unit. Words may be found on horizontal, vertical or diagonal lines or in reverse directions. List of words used is furnished for your guidance. Draw around energy words which you find has been done for the word "power".

P O P U L A T I O N K T C N R L M R D U B T U
G W R E W C H E M I C A L O B Y A T L N N H S
P A R T I C U L A T E S C I K L S I G E W S G
O T G K N S A V E X D S U S O E S A M G A M E
L E R U D E M A N D S O C S T S A E T M H O N
L R E C R U D E N A E R O U O G L Y L E M G E
U E N V I R O N M E N T A F U E L A A N A E R
T L G E N E R A T I O N H I O M C T E I U O A
I E R S C H O S U N L A M S K I L O W A T T T
O C E D I E L S E T O L A S T E A M G P T H O
N T S L W A S T E R P O T I R N R E A P C E R
H R O M O T U I A V O O R O A T N A S L C R P
S I U C A L O R I E M C O N T R O L O I O M E
R C R A N W O R K E P O T E N T I A L A M A T
E I C R G E R I A T O M N O I S N E I N B L R
S T E B R N C E I N F M A T T E R Z N C U X O
E Y P O W E R O T I O U R A N I U M E E S Y L
R D A N V R H I L L T N U C L E A R M O T Y E
V T O R S G A S E O K I N E T I C L E V I N U
E U R E C Y C L I N G T P B A R R E L F O O M
S T O R A G E B Y S H Y D R O C A R B O N S T

1. atom
2. energy
3. calorie
4. carbon
5. coal
6. community
7. control
8. coolant
9. critical mass
10. core
11. ecology
12. environment
13. fission
14. fusion
15. fossil
16. fuel
17. food
18. element
19. gas
20. hydrocarbons
21. electricity
22. ion
23. kilowatt
24. mass
25. matter
26. nuclear
27. particulates
28. pollution
29. population
30. power
31. recycling
32. smog
33. steam
34. solar
35. geothermal
36. wind
37. water
38. uranium
39. waste
40. appliance
41. generation
42. heat
43. storage
44. BTU
45. demand
46. kinetic
47. petroleum
48. potential
49. chemical
50. coke
51. combustion
52. crude
53. gasoline
54. generator
55. heat
56. resource
57. barrel
58. work
59. sun
60. ? (See if you can find it!)

ART/PHOTOGRAPHY

Grade Level 5-12

Purpose: To become more aware of the energy problem.

Activities:

1. Have students make a poster portraying some aspect of the energy problem. Have posters displayed around the school and give prizes for the best energy poster submitted.

2. Have students make a mural which describes or depicts the historical progression of fuel uses from wood to nuclear fuel based on man's progressive technological abilities. Include wood, peat, lignite, coal, oil, natural gas, nuclear fission, and nuclear fusion. (This project could involve several students, with some conducting research and others doing the artwork.)

3. Take or have students go to an art gallery and conduct an inventory of art objects which depict energy use. Discuss the energy conversion being illustrated and attempt to hypothesize the original influence on the artist.

4. Have students create bulletin board displays of pictures, articles, and clippings from current magazines and newspapers which depict the current energy situation. Arrange to show these in school and, if possible, in public buildings and retail stores in the community.

5. Have students draw a cartoon on the energy shortage for publication in the school and/or local newspaper. Cartoons could show humorous aspects of conserving energy or, possibly, some of the incongruities of "little savings" versus "massive waste".

6. Have students sketch, photograph, or visually describe "power". Discuss and compare different kinds of power. Which of these is more powerful? Least powerful? Why?

7. Have each student bring in five unique pictures showing energy misuse. Teams of five students then could make a collage using all the pictures. Further, they could write a poem depicting the collage.

A Teacher's Guide for Energy Conservation, University of Tennessee.

CONSUMER EDUCATION

Grade Level 6-12

Purpose: To show how consumers can affect the consumption of energy.

Activities:

1. Using the following headings, describe the ways consumers may be most severely affected by fuel shortages:

   a. use of home appliances
   b. use of automobiles
   c. heating and cooling homes
   d. purchase of new consumer goods
   e. taking vacations
   f. purchase of food
   g. beating inflation

2. Predict the ways in which consumer choices, spending patterns, and lifestyles may change in these categories as a result of the fuel shortage:

   a. foods
   b. clothing and textiles
   c. home appliances
   d. autos
   e. travel
   f. insurance
   g. entertainment

3. Discuss the kind of campaign that would be most effective in reducing electrical energy consumption. Who should pay for the campaign? Should this be a negative type of educational effort (i.e., urging people not to use something) or a positive effort (i.e., urging people to do something out of self-interest)?

4. Investigate and report on the steps to conserve energy that manufacturers of home appliances can take in:

   design
   marketing
   promotion and advertising
   educating users

A Teacher's Guide for Energy Conservation, University of Tennessee.

ENGLISH/DRAMA

Grade Level 5-12

Purpose: To show how the energy problem is a social problem.

Activities:

1. Write a paper describing what you think is the most pressing energy problem today and explain why.

2. Write editorials and/or short stories on the energy situation. Submit these to the school and/or to the local newspapers. Possible topics and subjects are:

   a. Why I prefer small cars
   b. Conserving energy is the best thing that ever happened at our house
   c. The effect of the energy situation upon attitudes and actions of car buyers
   d. The cynicism of some people toward the reality of a gas shortage
   e. Why the Arab oil embargo was a great gift to the American people
   f. Car pools--a great way to meet people and make friends
   g. How to feel toasty warm at 65 degrees
   h. Advantages of the 55 m.p.h. speed limit
   i. What the higher energy price means to the poor nations

3. Write a paper detailing any changes in lifestyle as a result of the gas shortage in the winter of 1973-74 or 1976-77.

4. Write an essay which compares and contrasts modern and ancient concepts of the sun and its influence on human life.

5. Write a poem that could serve as an obituary for the low gas mileage automobile.

6. Write a play on "U.S. Energy" or "Oklahoma Energy." For example, the play might be entitled "How Did We Get to Where We Are Now," and might include as characters: "Crude" Oil, "Nat" U. Gas, Harry Hydro, "Nuke" Power, Clarence Coal, Sally Solar, G.T. Thermal, Wendy Mills, Oil Shales. If your school has a winner, why not make the play a part of "Energy Awareness Week"? Consider taking the play around to other schools in the district and/or presenting to civic organizations, Parents Night, etc.

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7. Conduct a debate, dividing the class into the following groups:

   a. Manufacturers (including textiles, aluminum, automobiles)
   b. Conservationists
   c. City, county, and state planners
   d. Oil companies, coal mine owners, foresters, teachers, workers
   e. Judges (three are sufficient)
   f. Young citizens

   Each group must proceed to assert its right to control the production and use of the energy resources of the world and must defend its position. Set a time limit on each group's presentation. After the deliberations are completed, have the judges report to the class on which group they felt had the best program and why.

8. A small group may begin a file of magazine and newspaper articles related to the oil shortage in the U.S. Special attention should be given to those articles which provide suggestions for increasing the availability of oil, such as (a) exploiting Prudhoe Bay oil transported through the Alaskan Pipeline; (b) liquefying coal; (c) mining oil shale; (d) increasing off-shore explorations; and (e) requiring more efficient use of oil by all consumers.

   Assign a panel of students to weigh the pros and cons of each of the possibilities suggested by the clippings. This panel could hear the arguments of three students selected to play the roles of, respectively, the oil company executive, an environmentalist, and an official of the federal energy department. Then, after the arguments have been heard and the panel has deliberated, conduct a secret ballot of members of the class to determine the practicality or feasibility of each suggestion.

JOURNALISM

Grade Level 4-12

Purpose: To make the student aware of the various components of the energy problem.

Activities:

1. Write scenarios projecting what will happen in the future with regard to the energy crisis: (a) if we conserve; (b) if we don't conserve; and (3) if we place a moratorium on nuclear power.

2. Prepare a newscast portraying the energy situation from 1900 to the present.

3. Create a one-minute radio or television commercial focusing on some aspect of energy conservation. Use any medium for a class presentation. Consider how many people your commercial must reach in order to bring about the desired change in school and community attitudes.

4. Simulate the television program "Meet the Press." This requires a moderator, four reporters, and a guest--the "Energy Czar." While the Czar is out of the room, the class should generate questions about today's critical issues. After his return, the reporters will interact with the Czar.

5. Prepare (and print, if feasible) a booklet on "Ways Kids Can Help to Save Energy"--in the home, in the school, in the car, in stores, and in the community. This project could be timed to coincide with "Energy Awareness Week".

A Teacher's Guide for Energy Conservation, University of Tennessee.

SOCIOLOGY/PSYCHOLOGY/PHILOSOPHY

Grade Level 4-12

Purpose: To become aware of the social aspects of the energy problem.

Activity:

1. In what ways might our nation benefit from the energy crisis? Can you classify benefits under headings of social, economic, political, environmental, and moral?

2. Compare the lifestyle in an underdeveloped nation with your own. Consider the energy consumed by both and discuss the differences.

3. Estimate the minimum amount of energy you would need for bare existence.

4. When people get angry or upset, or even when they feel really good, there is usually one thing or person that makes them feel that way. Make a list of things related to the energy situation that affect your emotions.

5. A "traditional value" in this country has been that if something <u>can</u> be done, it <u>ought</u> to be done. Discuss what would happen if that value were changed to become: "The value of a process or product must be based on the extent to which it creates the greatest social good." What implication(s) would this have for policy-makers? How would it affect the growth of some industries? Where does energy fit into this picture?

AN ENERGETIC GAME!
(Bingo)

Grade Level 4-12

Purpose: To review cognitive information presented in previous lessons.

Materials: Bingo Handout Sheets

Activity:

The games included here are examples of the format that might be employed at the culmination of any unit on energy. You can construct your own game by substituting clues and corresponding answers that are suitable to the content and level of difficulty you have covered.

Distribute a mimeographed copy of the 16-square card to each student. Ask the student to cut out the squares and rearrange them in any order he/she wishes. This is essential if students are not all to attain "BINGO" at the same time. The squares should then be glued onto another sheet of paper.

Either a student or the teacher can be the "caller" and read the energy-related clue to the other students. Do not read the numbers of the clue. The clues may also be cut out and chosen randomly from a box by an assistant.

As the clue is read, the players will mark the answer on their card with an "X". The first player to get four boxes in a row is the winner and should call out "BINGO". The teacher should very quickly check his answers to be sure they are marked correctly. If the student was not correct then he is eliminated and game continues.

As a follow-up activity, divide the class into small groups. Each group of students should prepare another set of 16 clues and answers that can be duplicated for the remainder of the class. The group who composed the clues and answers would administer the game.

Energy Environment Mini-Unit Guide, NSTA, p. 14.

BINGO Scoreboard
(Intermediate Level)

(Duplicate a copy for each student. Have students cut into squares and glue in differing order on another sheet of paper.)

1 SUN	5 COAL	9 NUCLEAR	13 STRIP MINING
2 COAL, NATURAL GAS	6 GEOTHERMAL	10 URANIUM	14 GREEN PLANTS
3 ELECTRICITY	7 NATURAL GAS	11 WELLS	15 GASOLINE
4 OIL	8 MINES	12 WIRES	16 FOOD

Example for Intermediate Level

BINGO ENERGY CLUES

(Do not mention number!)

1. The major source of energy found in nature.
2. The three fossil fuels are oil, _____, and _____.
3. Most of the appliances in our homes are powered by _____.
4. A fossil fuel that is in liquid form.
5. An energy source that is obtained from deep or surface mines.
6. Energy source in the form of steam.
7. The fossil fuel that has the shortest predicted life span is _____.
8. Black lung disease was obtained by working in _____.
9. The name of the energy that results from splitting an atom.
10. The fuel that is used to produce nuclear energy.
11. Natural gas and oil are obtained from the ground with _____.
12. Electricity is transmitted to our homes through _____.
13. The process of removing coal from the surface of the earth is called _____.
14. Most food items are obtained from, or can be traced back to _____.
15. One of the products of an oil refinery is _____.
16. Humans obtain their energy from _____.

PETROLEUM AND THE WAY YOU LIVE

Fill in the blanks in the following story from the list of words at the bottom of the page (all products made from petroleum). Each word will be used at least once. How many petroleum or *petrochemical* products can you think of that you used before school this morning?

Sam Super, a seventh grader at O.K. Junior High, hated to get up one dreary, rainy day. Sam flicked on the _____ lights and washed his hair with _____ shampoo. To cheer himself up, he put on his brightest plaid _____ sweater. On the way downstairs, Sam passed his sister's room as she was fixing her new hairdo with a can of _____ hairspray. Down in the kitchen, Sam's mother had fixed him some eggs in a _____-coated pan, using her _____ range. Sam's mother complained that he ate too quickly from the colorful _____ _____ plate and insisted that, because it was raining, Sam wear his _____ boots. All that hassle had given him a headache, so he gulped down an _____, grabbed his peanut butter sandwich wrapped in _____ and banged the _____ storm door on the way out. On the way to the corner, Sam slipped in a puddle on the _____ roadway. Finally, he climbed on the bus, powered by high octane _____. He sank back onto the _____-covered seat and unrolled a butterscotch drop from a _____ wrapper, opened his _____ notebook, and started his homework from the night before.

---

plexiglass	plastic wrap	aspirin
teflon	gasoline	electric
detergent	vinyl	natural gas
aerosol-propelled	acrylic knit	synthetic leather
asphalt	melamine plasticware	cellophane
	synthetic rubber	

FEA, The Energy Challenge

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Sam Super, a seventh grader at O.K. Junior High, hated to get up one dreary, rainy day. Sam flicked on the *electric* lights and washed his hair with *detergent* shampoo. To cheer himself up, he put on his brightest plaid *acrylic knit* sweater. On the way downstairs, Sam passed his sister's room as she was fixing her new hairdo with a can of *aerosol-propelled* hairspray. Down in the kitchen, Sam's mother had fixed him some eggs in a *teflon*-coated pan, using her *electric or natural gas* range. Sam's mother complained that he ate too quickly from the colorful *melamine plasticware* plate and insisted that, because it was raining, Sam wear his *synthetic rubber or vinyl* boots. All that hassle had given him a headache, so he gulped down an *aspirin*, grabbed his peanut butter sandwich wrapped in *plastic wrap* and banged the *plexiglass* storm door on the way out. On the way to the corner, Sam slipped in a puddle on the *asphalt* roadway. Finally, he climbed on the bus, powered by high octane *gasoline*. He sank back onto the *vinyl*-covered seat and unrolled a butterscotch drop from a *cellophane* wrapper, opened his *synthetic leather* notebook, and started his homework from the night before.

---

plexiglass	plastic wrap	aspirin
teflon	gasoline	electric
detergent	vinyl	natural gas
aerosol-propelled	acrylic knit	synthetic leather
asphalt	melamine plasticware	cellophane
	synthetic rubber	

WHAT CAN YOU DO TO SAVE ENERGY?

Part 1:

Brenda's mother and Wayne's father each work ten miles away from their homes. In a five-day week, each uses five gallons of gas driving to and from work. Wayne's father drives alone. Brenda's mother is in a car-pool in which she takes four other persons to work. If each of her passengers drove, each would also use five gallons of gas a week. Now that they car-pool, how much gasoline does Brenda's mother help save each week? _____; each year? _____. How could Wayne's father help save energy? _____ _____.

The Bailey's are going away on vacation. They are concerned about burglars and want a light on in their house from 7:30 to 11 o'clock each evening. Can you suggest how they might do this without wasting energy? _____ _____.

Selecting the right size electric light bulb can help save energy. On the package is listed the number of watts (the amount of power needed to make the light bulb work), the lumens (the brightness of the bulb), and the number of hours the bulb will last. With this information, how could you select the most efficient bulb? _____ _____.

John and his sister are going to wash clothes. He wants to do his three shirts separately. His sister wants to do them with her five blouses. Which way will conserve energy? _____ _____. Why? _____.

Jack has just come in the door after playing in the snow and feels too warm. He wants to turn down the thermostat until he feels comfortable. His mother tells him to leave it where she has set it at 68 degrees. Who is more energy-conscious? _____. Why? _____ _____.

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The Bailey's are going away on vacation. They are concerned about burglars and want a light on in their house from 7:30 to 11 o'clock each evening. Can you suggest how they might do this without wasting energy? *Install an inexpensive timer that turns the lights on and off*.

Selecting the right size electric light bulb can help save energy. On the package is listed the number of watts (the amount of power needed to make the light bulb work), the lumens (the brightness of the bulb), and the number of hours the bulb will last. With this information, how could you select the most efficient bulb? *Find the bulb that provides the most light with the least wattage*.

John and his sister are going to wash clothes. He wants to do his three shirts separately. His sister wants to do them with her five blouses. Which way will conserve energy? *washing them together*. Why? *More efficient use of water, soap, and electricity*.

Jack has just come in the door after playing in the snow and feels too warm. He wants to turn down the thermostat until he feels comfortable. His mother tells him to leave it where she has set it at 68 degrees. Who is more energy-conscious? *Mother*. Why? *Turning the thermostat up and down uses more energy than leaving it in one place*.

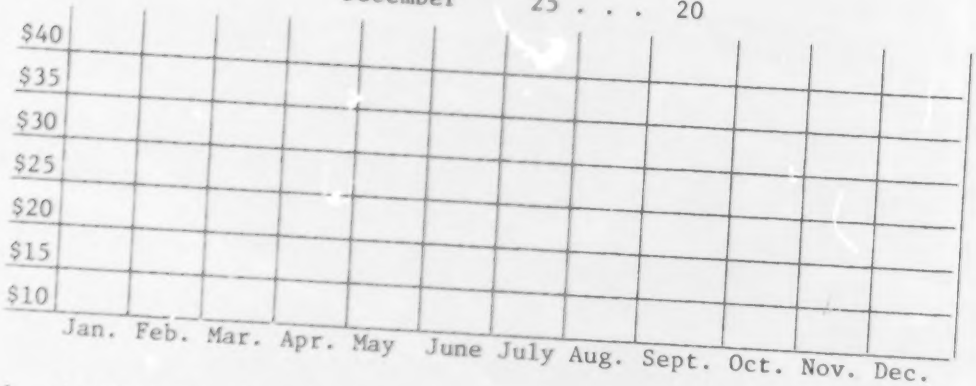
FEA, The Energy Challenge

WHAT CAN YOU DO TO SAVE ENERGY?

Part 2:

Below are the Hazleton's heating and air conditioning bills for two different years. In 1974, they had no insulation in their home. At the end of the year they had some installed, so the cost of heating and air conditioning in their home went down. In the graph below, place a dot for the cost of each month in 1974. Then draw a line between the dots. Do the same thing for 1975 in red. Compare the Hazleton's savings with insulation. How much did they save in January? _____ How much for the entire year? _____

	1974	1975
January	$35	$25
February	25	20
March	20	20
April	20	15
May	15	10
June	25	15
July	40	25
August	35	20
September	20	15
October	15	15
November	20	15
December	25	20



1. At what time(s) of the year is there the highest utility cost? Why? _____

2. At what time(s) of the year is there the greatest savings after insulation? _____

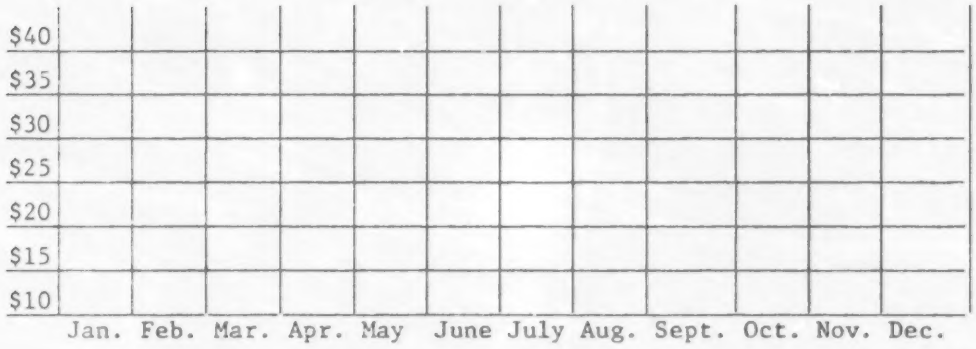
FEA, The Energy Challenge

WHAT CAN YOU DO TO SAVE ENERGY?

Part 2:

Below are the Hazleton's heating and air conditioning bills for two different years. In 1974, they had no insulation in their home. At the end of the year they had some installed, so the cost of heating and air conditioning in their home went down. In the graph below, place a dot for the cost of each month in 1974. Then draw a line between the dots. Do the same thing for 1975 in red. Compare the Hazleton's savings with insulation. How much did they save in January? *$10* How much for the entire year? *$80*

	1974	1975
January	$35	$25
February	25	20
March	20	20
April	20	15
May	15	10
June	25	15
July	40	25
August	35	20
September	20	15
October	15	15
November	20	15
December	25	20



1. At what time(s) of the year is there the highest utility cost? Why? *Jan. and July. Coldest and hottest months*

2. At what time(s) of the year is there the greatest savings after insulation? *July and August*

IT'S EVERYONE'S JOB: Read the idea for conserving energy in the column headed Conservation Method. Then answer the questions in the spaces provided.

Conservation Method	What sector of society? (circle one or more)	What energy resource does this save? (write: natural gas, petroleum . . . or coal)	Does it use less energy? (Yes or No)	Does it use energy more efficiently? (Yes or No)	How can we encourage this conservation measure? (brainstorm as many ideas as you can)
Flying passenger airplanes only when they are full	Transportation Industrial Commercial Residential				
Shipping freight by train instead of by truck	Transportation Industrial Commercial Residential				
Replacing incandescent light bulbs with fluorescent lights	Transportation Industrial Commercial Residential				
Reducing heating and cooling where space is unoccupied	Transportation Industrial Commercial Residential				
Recycling, steel, paper, glass, aluminum	Transportation Industrial Commercial Residential				
Developing and using mass transit systems	Transportation Industrial Commercial Residential				

FEA, The Energy Challenge

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Conservation Method	What sector of society? (circle one or more)	What energy resource does this save? (write: natural gas, petroleum . . . or coal)	Does it use less energy? (Yes or No)	Does it use energy more efficiently? (Yes or No)	How can we encourage this conservation measure? (brainstorm as many ideas as you can)
Flying passenger airplanes only when they are full	Transportation Industrial Commercial Residential	*Petroleum*	*Yes*	*Yes*	
Shipping freight by train instead of by truck	Transportation Industrial Commercial Residential	*Petroleum*	*Yes*	*Yes*	
Replacing incandescent light bulbs with fluorescent lights	Transportation Industrial Commercial Residential	*Coal Petroleum Natural Gas*	*Yes*	*Yes*	
Reducing heating and cooling where space is unoccupied	Transportation Industrial Commercial Residential	*Petroleum Natural Gas*	*Yes*	*Yes*	
Recycling, steel, paper, glass, aluminum	Transportation Industrial Commercial Residential	*Coal Petroleum Natural Gas*	*Yes*	*Yes*	
Developing and using mass transit systems	Transportation Industrial Commercial Residential	*Petroleum*	*Yes*	*Yes*	

FEA, The Energy Challenge

The Oil We Import

Because America's demand for oil is greater than its supply, we must buy oil from other countries to help meet the demand. This is called *importing*. During the last five years our imports of oil have doubled, and the cost per barrel has increased more than four times.

1. Find each country shown on the graph on a world map. Then list each country in its proper region below. Beside each country's name write the percentage of oil the U.S. imports from it.

North America

_____ _____

Latin America

_____ _____

_____ _____

The Mideast

_____ _____

_____ _____

_____ _____

Africa

_____ _____

_____ _____

Southeast Asia

_____ _____

2. What do the letters OPEC stand for? (The OPEC nations have formed an association to regulate the price they charge for their crude oil.)

_____

3. What percentage of imported U.S. oil comes from OPEC nations?

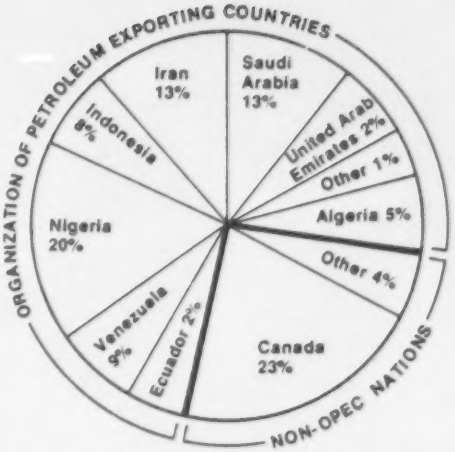
_____

4. Which country sells the U.S. the most crude oil? (This country says it will need to end all shipments to the U.S. by 1982.)

_____

5. Why does the U.S. need to import oil?

_____



PERCENT OF TOTAL U.S. CRUDE IMPORTS IN 1974

Check which of these solutions to our energy consumption problem seems workable to you.

- ☐ Increase domestic production of fossil fuels
- ☐ Decrease our demand for oil
- ☐ Develop new energy alternatives
- ☐ Increase oil imports to fill growing demand
- ☐ Stop importing; become energy independent

Other solutions (Could you name some?)

_____

_____

_____

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PERCENT OF TOTAL U.S. CRUDE IMPORTS IN 1974

1. Find each country shown on the graph on a world map. Then list each country in its proper region below. Beside each country's name write the percentage of oil the U.S. imports from it.

North America	
Canada	23%
Latin America	
Venezuela	9%
Ecuador	2%
The Mideast	
Iran	13%
Saudi Arabia	13%
United Arab Emirates	2%
Africa	
Nigeria	20%
Algeria	5%
Southeast Asia	
Indonesia	8%

2. What do the letters OPEC stand for? (The OPEC nations have formed an association to regulate the price they charge for their crude oil.)
   Organization of Petroleum Exporting Countries
3. What percentage of imported U.S. oil comes from OPEC nations?
   73%
4. Which country sells the U.S. the most crude oil? (This country says it will need to end all shipments to the U.S. by 1982.)
   Canada
5. Why does the U.S. need to import oil?
   Because its demand is greater than its domestic supply.

Check which of these solutions to our energy consumption problem seems workable to you.

- ☐ Increase domestic production of fossil fuels
- ☐ Ducrease our demand for oil
- ☐ Develop new energy alternatives
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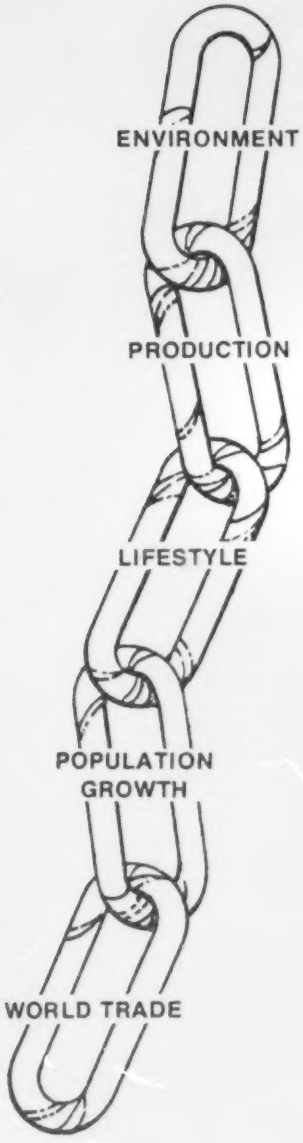
Other solutions (Could you name some?)

The Energy Chain



Population growth, production of goods and services, dependency on foreign oil supplies, environmental health and safety, and the effect of these on our lifestyles — each of these is a link in the chain of energy use. Each is part of the energy challenge.

Draw a line from each short story to the appropriate link. Form small discussion groups. With others in your group, define the problem in the following situations and discuss what your solutions might be.

1. Time: One possible day in the future. Canada has decided to stop exporting oil. Some of the other oil-producing countries decide to band together and withhold oil in order to raise prices. U.S. supplies of oil are suddenly cut in half. There is no milk or bread in your house, no gas in the car, and you live 5 miles from the nearest store. What kinds of problems would you and your community face if there were a serious oil-shortage? How could you solve these problems?

2. Each year the number of students in your classroom increases. This means more seats in less space, more noise, less personal help from your teacher. A new business has opened in your town, employing 300 people. Suddenly, your class size has doubled. How will this affect you and your school?

3. A large utility company is planning to build an electric generating plant right where you and your family camp and fish every summer. The coal resources are nearby (mining hasn't started yet, though) and the city 500 miles away is desperately short of electric power. Should the plant be built? Why or why not?

4. Your uncle manages a large farm that produces many food products. He operates tractors and giant combines; he runs a gasoline-powered irrigation system, cow-milking machines and crop-drying equipment. He uses fertilizers made from petroleum. Because petroleum is scarce, his costs have more than doubled. If he cuts back on his use of petroleum-based products, he would seriously reduce food production per acre. Is there any way he can cut back on his reliance on petroleum? How can consumers help cut energy needs for food production?

5. The annual operating budget of your city (your public tax money) can pay for either completion of the super highway system or enlarging the suburb-to-city mass transportation system, but not both. Most commuters don't like to ride buses, so the buses are usually only half full. The vote is coming up at the council meeting next week. How should the council vote?

FEA, The Energy Challenge

The Energy Chain

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HIDDEN WORD REVIEW

T	R	A	I	N	C	E	M	B	A	R	G	O	P	G
E	N	V	I	R	O	N	M	E	N	T	A	L	R	E
L	U	M	E	I	N	S	T	E	I	N	S	I	I	O
E	C	A	P	D	S	R	O	Y	B	L	O	F	M	T
C	L	U	S	Y	E	P	L	L	U	T	M	E	A	H
T	E	I	U	M	R	M	E	R	A	M	U	S	R	E
R	A	N	P	B	V	O	A	C	A	R	S	T	Y	R
I	R	S	P	A	A	Z	L	N	E	R	N	Y	E	M
C	L	U	L	W	T	R	L	Y	D	O	I	L	C	A
I	O	L	Y	I	I	E	R	A	S	B	C	E	L	L
T	W	A	T	T	O	N	B	E	Y	I	P	R	O	S
Y	A	T	L	L	N	I	D	E	L	O	S	E	A	M
B	O	E	G	A	S	I	F	I	C	A	T	I	O	N
B	P	O	P	U	L	A	T	I	O	N	L	I	H	P
S	E	C	O	N	D	A	R	Y	E	N	E	R	G	Y

Hidden in the diagram at left are energy-related words that you have met throughout the activities in this section. There are 30 words altogether. Try to find as many as you can and circle them across, down, or diagonally. The letters of each word are always in sequence. You can answer the questions on these two pages with words from the puzzle.

1. In 1776, James ____ put the steam engine to work and started an energy revolution.

2. Albert _____ prepared the way for the atomic age in 1905.

3. The three fossil fuels are ____, ___, and ___.

4. About 65 percent of our coal supply is used to generate _____.

5. A ____ of coal is a layer of coal lying beneath the surface of the earth.

6. Electricity is not a primary energy source; it is a _____ source.

7. Oil is measured by the _____, which is the same as 42 gallons.

8. Burning solid wastes at high temperatures without oxygen is called _____.

9. An almost inexhaustible source of energy that does not pollute, is inexpensive to maintain but costly to install is_____ energy.

_____

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10. Sunlight can be captured using a solar ___ to provide electric power to a building.

11. Being careful about the amount of energy we use, by practicing _____, we can save valuable energy.

12. If you _____ your house you can keep the heat in in the winter and out in the summer.

13. Shipping freight by _____ rather than by truck is much more energy-efficient.

14. Coal _____ turns coal into a clean, easily transportable fuel that can be used like natural gas.

15. The Organization of Petroleum Exporting Countries is usually abbreviated ____.

16. As a result of the oil _____ in 1973, there was a shortage of gasoline and fuel oil.

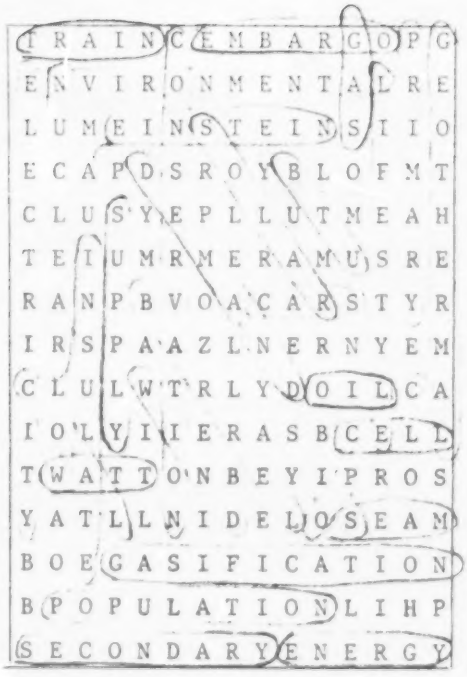
17. One of the worst sources of pollution in the U.S. is ____ without emission control devices.

18. Prices very often go up or down because of supply and _____.

19. More and more people in every country in the world means a _____ growth that will use more and more energy in the years to come.

20. We will have to reach a delicate balance between _____ _____ concerns and our growing need for _____.

HIDDEN WORD REVIEW


T R A I N C E M B A R G O P G
E N V I R O N M E N T A L R E
L U M E I N S T E I N S I I O
E C A P D S R O Y B L O F M T
C L U S Y E P L L U T M E A H
T E I U M R M E R A M U S R E
R A N P B V O A C A R S T Y R
I R S P A A Z L N E R N Y E M
C L U L W T R L Y D O I L C A
I O L Y I I E R A S B C E L L
T W A T T O N B E Y I P R O S
Y A T L L N I D E L O S E A M
B O E G A S I F I C A T I O N
B P O P U L A T I O N L I H P
S E C O N D A R Y E N E R G Y

Hidden in the diagram at left are energy-related words that you have met throughout the activities in this section. There are 30 words altogether. Try to find as many as you can and circle them across, down, or diagonally. The letters of each word are always in sequence. You can answer the questions on these two pages with words from the puzzle.

1. In 1776, James *Watt* put the steam engine to work and started an energy revolution.

2. Albert *Einstein* prepared the way for the atomic age in 1905.

3. The three fossil fuels are *coal*, *oil*, and *gas*.

4. About 65 percent of our coal supply is used to generate *electricity*.

5. A *seam* of coal is a layer of coal lying beneath the surface of the earth.

6. Electricity is not a primary energy source; it is a *secondary* source.

7. Oil is measured by the *barrel*, which is the same as 42 gallons.

8. Burning solid wastes at high temperatures without oxygen is called *pyrolysis*.

9. An almost inexhaustible source of energy that does not pollute, is inexpensive to maintain but costly to install is *solar* energy.

FEA, The Energy Challenge

10. Sunlight can be captured using a solar *cell* to provide electric power to a building.

11. Being careful about the amount of energy we use, by practicing *conservation*, we can save valuable energy.

12. If you *insulate* your house you can keep the heat in in the winter and out in the summer.

13. Shipping freight by *train* rather than by truck is much more energy-efficient.

14. Coal *gasification* turns coal into a clean, easily transportable fuel that can be used like natural gas.

15. The Organization of Petroleum Exporting Countries is usually abbreviated *OPEC*.

16. As a result of the oil *embargo* in 1973, there was a shortage of gasoline and fuel oil.

17. One of the worst sources of pollution in the U.S. is *cars* without emission control devices.

18. Prices very often go up or down because of supply and *demand*.

19. More and more people in every country in the world means a *population* growth that will use more and more energy in the years to come.

20. We will have to reach a delicate balance between *environmental* concerns and our growing need for *energy*.

METER READING

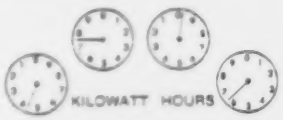
Grade Level 4-12

Objective: To teach students to be able to read their home gas and electric meters

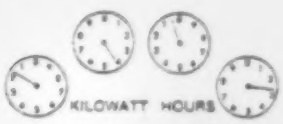
Activity: Students will take readings from meters at home, copy the position of the pointers on the dials and bring to school. The following exercises should help them to read their own meter.

1. Electric meters measure the amount of electricity used in your home. The greater the amount of electricity used, the more rapidly the pointers move. The meter is affected by the amount of current flowing into your house and the voltage or pressure it is under.

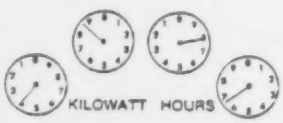
   Most meters have four or five dials. The dials are read from left to right and measure kilowatt-hours (a 100-watt light bulb burning for one hour uses 100 watt-hours of electricity--a kilowatt-hour is 1000 watt-hours). When the pointer is between two digits, always read the smaller. For example, the following dials would be read 4796 KWH.



   What is the reading of each of the following electric meters?

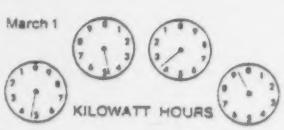


_____KWH



_____KWH

   Find the cost of the electricity consumed during the month of (1) January and (2) February at the rates given on the rate schedules following this activity if the meters were read on



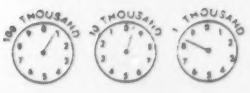
(Jan. 1-Feb. 1)_____KWH used (Feb. 1-Mar. 1)_____KWH used

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

2. The gas meter is read in a similar manner, except that it measures cubic feet of gas consumed. For example, the following meter would be read: 164,000 cu. ft.

Cubic Feet

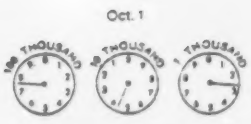
What is the reading of each of the following gas meters?



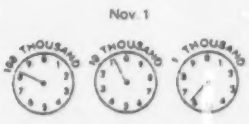
_____ Cubic Feet

_____ Cubic Feet

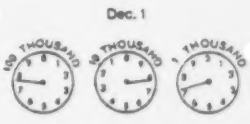
Find the cost of the gas consumed during the months of (1) October and (2) November at the rates given below if the meters read on:



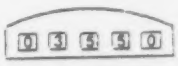
(Oct. 1-Nov. 1)
_____Cubic Feet



(Nov. 1-Dec. 1)
_____Cubic Feet



3. Digital meters--some large consumers have digital meters. An example is:



Extended Activities:

a. Students may try to figure out why adjacent dials rotate in opposite directions.

b. Students may build a model meter out of wood, cardboard, etc.

c. A meter is a small induction motor. Students may be assigned to explain the theory behind the operation of the meter.

ELECTRICITY RATES
(OG&E, Oklahoma City)
(June 29, 1977)

Residential

Summer:

First	16 KWH	--	$1.04
Next	24 KWH	--	.04107/KWH
Next	100 KWH	--	.03607/KWH
Next	460 KWH	--	.02407/KWH
Next	900 KWH	--	.02157/KWH
Next	1000 KWH	--	.02107/KWH
Over	2500 KWH	--	.01807/KWH

Winter:

First	16 KWH	--	$1.04
Next	24 KWH	--	.04107/KWH
Next	100 KWH	--	.03607/KWH
Next	460 KWH	--	.02407/KWH
Next	1900 KWH	--	.01307/KWH
Over	2500 KWH	--	.01207/KWH

To determine total billing, calculate base costs for KWH used from above schedule; to this amount add (number of KWH used x *$.009897/KWH); then add State and City Sales Tax to this subtotal. In some areas there is also a franchise amount (1 percent in Oklahoma City) to be added to determine total billing.

*Fuel adjustment factor

GAS RATES
(ONG, Oklahoma City)
(June 14, 1977)

1 MCF = 1000 Cubic Feet

Summer Residential Rates:

First	MCF		$2.43
Second	MCF		1.50
Third	MCF		1.50
Next	4 MCF		1.280/MCF
Next	13 MCF		1.080/MCF
Next	80 MCF		1.104/MCF
Next	100 MCF		1.004/MCF

To determine total billing, calculate costs for MCF consumption from above schedule; to this amount add (consumption in MCF x *$.626); then add State and City Sales Tax to this subtotal.

*Field adjustment price

ELECTRIC METER READING

Grade Level 6-12

Purpose: To acquaint the student with the method of reading an electric meter and interpreting an electric service billing.

Concept: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

Reference: Living with Electricity, Columbus and Southern Ohio Electric Company. Activity suggested by Yvonne A. Mather, Science Teacher, Canfield High School, Canfield, Ohio.

Activity: The teacher will distribute copies of the accompanying material to all students and, with the aid of a master copy on the overhead projector, guide them through the steps in reading the electric meter. (Teacher: use first page of Meter Reading activity, page 257.)

Following the same basic procedure, the teacher guides the student through a reading and explanation of the indicated items on the electric service bill, giving special attention to the figures which indicate the kilowatt hours used. (Bring a bill from home or get sample bill from local utility company.)

Several costs of operation of appliances in the home can be worked out using the rate chart included in this activity. (Electrical Power Usage Chart from page 220 will be useful for this.) It may be a good idea to check your local power company to determine if the rates are substantially different from those included here.

Follow-Up: Students record daily kilowatt readings (at the same time each day) for one month, recording these data in a simple journal which also includes some observations about the temperature, appliance use, and other pertinent factors which might affect the amount of use of appliances.

ERIC/SMEAC, Energy Activities for the Classroom.

RATING SCALES - JUNE 1977
(OG&E, Oklahoma City)

First	16 KWH	--	$1.04
Next	24 KWH	--	.04107/KWH
Next	100 KWH	--	.03607/KWH
Next	460 KWH	--	.02407/KWH
Next	900 KWH	--	.02157/KWH
Next	1000 KWH	--	.02107/KWH
Next	2500 KWH	--	.01807/KWH

To determine total billing, calculate base costs for KWH used from above schedule; to this amount add (number of KWH used x *$.009897/KWH); then add State and City Sales Tax to this subtotal. In some areas there is also a franchise amount (1 percent in Oklahoma City) to be added to determine total billing.

*Fuel adjustment factor

Kilowatt-Hour Record

(Student Activity Sheet)

Read your kilowatt-hour meter at home and record the reading. A. _____

Read meter one week later and record the reading. B. _____

Subtract B from A to determine KWH used during the first week of your experiment. C. _____

During the second week, encourage your family to conserve all the electricity possible. At the end of your second week, again read the meter and record. D. _____

Subtract D from B to determine KWH used during the second week of your experiment. E. _____

Subject E from C to determine how much electric energy your family saved over the previous week. F. _____

1. Were you successful or did you use more electricity?

2. If you used more, can you explain why?

3. Why would someone with an electrically-heated home have to consider the temperature during the two weeks?

4. List all the energy-saving steps your family took.

COSTS OF USING APPLIANCES

Grade Level 6-12

Purpose: To show how much it costs to operate various appliances.

Activity:

1. Which of the appliances listed below are in your home?

___Refrigerator	___Central Air Conditioning
___Electric Range	___Clothes washer
___Gas Range	___Electric Clothes dryer
___Dishwasher	___Gas Clothes dryer
___Black and white TV set(s)	___Freezer
___Color TV set(s)	___Room air conditioner(s)

What is the capacity of your refrigerator in cubic feet? _____

2. A group of major electrical household appliances is listed on the chart on the next page. Fill out this chart as you answer the items below:

   a. First, from what you know, rank the appliances from "1" (high) to "8" (low) as to their approximate wattage in Column 1.

   b. Skip Column 2. In Column 3, rank the appliances from "1" (high) to "8" (low) as to your opinion on their estimated kilowatt hours consumed annually.

   c. Next, in Column 5, rank these same appliances from "1" (highest cost) to "8" (lowest cost) according to your own estimate of their annual operating costs, assuming a rate of 4¢ per kilowatt hour.

   d. Now, from information supplied by your teacher or from data secured on your own, place the actual wattage of each appliance in Column 2. From these figures, determine the actual rank of each appliance. Compare Column 1 with Column 2 to see how close you came to getting the right order.

   e. Again, from your data, place the actual kilowatt-hours and ranks beside each appliance in Column 4. How close were your estimates?

A Teacher's Guide for Energy Conservation, Environmental Center, University of Tennessee, Knoxville, Tennessee.

f. Finally, in Column 6, rank the appliances according to their annual operating costs provided by your data. Compare these actual ranks with your earlier estimates.

	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
	Estimated Wattage (Rank only)	Actual Wattage and Rank	Estimated Annual kwh's (Rank only)	Actual Annual kwh's and Rank	Estimated Annual Operating Cost (Rank only)	Actual Annual Operating Cost and Rank
Freezer (15 cubic feet)						
Frostless refrigerator/freezer (14 cubic feet)						
Electric range with oven						
Color television (solid state)						
Room air conditioner						
Automatic washing machine*						
Electric clothes dryer*						
Dishwasher						

*Do not include kilowatt-hours for heating water used in these appliances.

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ANNUAL ENERGY REQUIREMENTS OF ELECTRIC
HOUSEHOLD APPLIANCES

Appliance	Average Wattage	Annual kwhr Consumption	Annual Cost*
Air cleaner	50	216	$ 8.64
Air conditioner (room)	997	1,032**	41.28
Bed covering	177	147	5.88
Blender	386	15	.60
Broiler	1,436	100	4.00
Carving knife	92	8	.32
Clock	2	17	.68
Clothes dryer	4,856	993	39.72
Coffee maker	894	106	4.24
Deep fryer	1,448	83	3.32
Dehumidifier	257	377	15.08
Dishwasher	1,201	363***	14.52
Egg cooker	516	14	.56
Fan (attic)	370	291	11.64
Fan (circulating)	88	43	1.92
Fan (window)	200	170	6.80
Floor polisher	305	15	.60
Freezer (15 cubic feet)	341	1,195	47.80
Freezer, frostless (15 cubic feet)	440	1,761	70.44
Frying pan	1,196	186	7.44
Germicidal lamp	20	141	5.64
Hair dryer	381	14	.56
Heater (portable)	1,322	176	7.04
Heat lamp (infrared)	250	13	.52
Heating pad	65	10	.40
Hot plate	1,257	90	3.60
Humidifier	177	163	6.52
Iron (hand)	1,008	144	5.76
Mixer	127	13	.52
Oven, microwave	1,450	190	7.60
Radio	71	86	3.42
Radio/record player	109	109	4.36
Range, with oven	12,200	1,175	47.00
Range, with self-cleaning	12,200	1,205	48.20
Refrigerator/Freezer (14 cubic feet)	326	1,137	45.48
Refrigerator/Freezer, frostless (14 cubic feet)	615	1,829	73.16
Roaster	1,333	205	8.20

*Based on a projection of 4¢ per kilowatt hour.

**Based upon 1,000 hours of operation per year; this figure will vary widely depending on area and specific size of unit.

***Does not include kilowatt hours for heating water.

ANNUAL ENERGY REQUIREMENTS OF ELECTRIC HOUSEHOLD APPLIANCES
(Continued)

Appliance	Average Wattage	Annual kwhr Consumption	Annual Cost*
Sandwich grill	1,161	33	$ 1.32
Sewing machine	75	11	.44
Shaver	14	1.8	.07
Sun lamp	279	16	.64
Television (black and white), tube type	160	350	14.00
Television (black and white), solid state	55	120	4.80
Television (color), tube type	300	660	26.40
Television (color), partial solid state	200	440	17.60
Toaster	1,146	39	1.56
Toothbrush	7	0.5	.02
Trash compactor	400	50	2.00
Vacuum cleaner	630	46	1.84
Vibrator	40	2	.08
Waffle iron	1,116	22	.88
Washing machine (automatic)	512	103***	4.12
Washing machine (manual)	286	76	3.04
Waste disposer	445	30	1.20
Water heater (standard)	2,475	4,219	168.76
Water heater (quick-recovery)	4,474	4,811	192.44

*Based on a projection of 4¢ per kilowatt hour.

***Does not include kilowatt hours for heating water.

All figures courtesy of Electric Energy Association, New York, New York, except "Air Conditioner (room)." Cost projection figures are @ 4¢/KWH rather than @ 2¢/KWH as in original materials.

BUYING ENERGY EFFICIENT GOODS

Grade Level 4-12

Purpose: To appreciate the role advertising plays in the energy choices we make.

Concept: The production and distribution of energy have environmental and economic consequences.

Materials: Paper, magazines and scissors.

Activity: Advertisements are written to make people buy a product. You must read or listen to ads very critically. Otherwise, you may purchase something that does not live up to your expectations. How do you decide what automobile to buy? What are some important things that make you choose an automobile? How does it handle? Does it get many miles to the gallon of gas line? Can it use economy fuel? How much does it cost? What are the dealers doing to make their car more appealing than their competitors?

1. On a piece of paper or on the chalkboard list the qualities of the most appealing automobiles that are important to you.
2. Collect ads for as many kinds of vehicles as you can. Do they tell you all you want to know? Are some facts missing? Do the ads say things you are sure about? How does their product conserve energy? What brands seem to be best according to what you think is important?
3. In several ads circle the words and phrases that make you want to buy the car. Cross out any that don't really tell anything important. Summarize, pointing out the importance of critical reading and listening in our present energy situation.

Extended Activities: This activity can be applied to other consumer items. Another good example to use are freezers (frost free versus others). Have students make up their own commercials. One may give a "super salesman" approach to an energy consuming device, and another may give an honest straight forward commercial for the same product.

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

ENERGY AND UNEMPLOYMENT

Grade Level 4-8

Objective: The students will discuss the importance of electrical usage to the community.

Activity: The class will discuss the importance of electrical usage to industries and to occupations to determine how an energy shortage would affect each job.

Extended Activities:

1. Make bulletin board displaying one industry shutting down and the outcome.

2. Visit local industry to observe electrical usage. Make diagram of the building and locate important electrical features.

3. Discuss how energy shortages, coal strikes, trucking strikes, high fuel costs, etc., affect employment; include specific plants and jobs in your community as well as those in other areas.

4. Discuss how technology affects jobs as well as the energy shortage. What type of technological advances would be beneficial to your area?

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

SUPPLY AND DEMAND

Grade Level 4-12

Purpose: To show how supply and demand affects price.

Concept: To maintain an acceptable (wants and needs) standard of living and preserve our environment, we must conserve our available energy resources while we are developing alternate energy sources.

Source: Jerry Shaw, Science Teacher, Stillwater, Oklahoma.

Materials: Candy bars (or other commodity)

Activity:

1. Choose two, five-member teams of students telling them that it takes money to play this game.

2. Explain to the students that you have nine candy bars (one less candy bar than there are students representing a certain limited commodity such as energy, food, natural resources or any other you may be discussing). In order for a team to win, at the end of the game, each member of that team must have at least one candy bar.

3. Auction off the candy bars.

4. As the supply decreases and the demand increases, the price will increase.

5. When the game is over the candy bars can be taken up and the money refunded, if desired.

Many variations can be made on this plan. What happens to the price when there is a surplus? What happens when prices are controlled at a low level?

ENERGY AND THE ECONOMY

Grade Level 8-12

Purpose: To develop appreciation of the effect of energy supply and demand on our nation's economy.

Activity:

A. Arab Oil Embargo

1. What effect has the Arab Oil Embargo with the corresponding raise in the price of oil had on our economy? How does the price of oil affect your wages, the price of clothing, the price of wheat, etc.? How have embargoes been handled in the past?

2. What effect has the increased profit for the Arabs had in their country? How has it changed their lifestyle? What do they do with their money? How can they invest it?

3. What effect does the increased wealth of the Arabs have on international relations? American foreign policy? American domestic policy? Is a war possible? What effect does it have on the U.S. if the Arabs begin buying land, companies, etc.?

B. What effect has the increased price of energy had on the stock market? Investigate the price of stocks of energy-related industries over the past two years. What would be the effect if the Arabs began investing heavily in the stock market? A graph showing the profits of major industries in the U.S. would be appropriate with energy-related industries outlined in red.

C. Study the structure of American oil companies: their power, tax privileges, costs, profits, investments in other energy sources besides oil, past and present relationship with oil-producing nations, role in the energy situation, search for new energy sources, etc.

Do the same for electric and gas companies.

D. How has the increased demand for energy, the current shortage and the oil embargo affected prices and wages in the U.S.? How has it influenced inflation? Why does an energy problem affect all prices and wages?

E. How has government policy changed since the oil embargo, especially on pollution and energy consumption? Why the abrupt change?

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

F. How does the current energy situation affect our international balance of payments?

G. What effect has increased energy demand had on our nation's economy? Investigate the rising demand for energy as related to population increase.

$AVE DOLLAR$

Grade Level 4-12

Objective: To make students aware of savings possible through conservation of gasoline.

Activity: Suggested types of problems

1. Mr. Burns had the tank of his car filled with gasoline and noted that the odometer read 14593. The next time he stopped for gasoline it required 14 gallons to fill the tank and the odometer read 14817. How many miles did the car average per gallon of gasoline?

   NOTE: Some time may need to be spent teaching children to compute miles/gallon.

2. If a man travels from New York to Cincinnati, a distance of 660 miles, and his car averages 15 miles per gallon of gasoline, how many gallons are required to make the trip? How many gallons would be required if his car averaged 22 miles per gallon? What would the cost be for each one, if gasoline were 55.9¢ per gallon?

3. How far can a car go on a tankful of gasoline if it averages 14 miles per gallon and the tank holds 18 gallons? How much farther could it travel if instead it averaged 22 mpg?

4. Correct tire inflation can save the average driver up to 50 gallons of fuel a year. If gasoline costs 55.9¢ per gallon, how much money would this save in a year?

5. Regular tune-ups can save the average driver 175 gallons of gasoline a year. How much savings is this with gasoline at 55.9¢ per gallon?

6. Driving at 70 miles an hour can take approximately 25 percent more gasoline per mile than driving at 50 miles an hour. Assume that, on a 300 mile trip, while travelling at 50 mph, your car has consumed 20 gallons of gasoline. How much more would it consume if you have travelled at 70 mph? How much more would this cost if gasoline were 55.9¢ a gallon.

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

7. Gerald Ford, when President, asked the automobile manufacturers to produce automobiles that would average 20 mpg. Average miles per gallon was 13.7 mpg. The average car travels about 10,000 miles per year. How many gallons are needed if your car averages 13.7 mpg? What is the gasoline cost for each if gasoline is 55.9¢ per gallon? How much would you save in a year if your car averaged 20 mpg instead of 13.7 mpg?

   There are about 100 million registered automobiles in the U.S. How many gallons of gasoline would be saved if all automobiles got 20 mpg? (You have already calculated how much would be saved by one automobile above.) How much money would be saved in the U.S. with gasoline priced at 55.9¢ per gallon?

Extended Activities: Many more problems can be discussed. Two pamphlets which are very helpful are 1977 Gas Mileage Guide for New Car Buyers and Don't be Fuelish, published by Energy Conservation and Environment, Federal Energy Administration, Washington, D.C. 20461. Obtain free copies from Fuel Economy, Pueblo, Colorado 81009.

ADVERTISING AND ENERGY SHORTAGES

Grade Level 7-12

Purpose: To determine if energy shortages have influenced advertising.

Concept: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

Activity: Review with the class an example or two of ways people have been motivated to use more energy in the past. Advertising extolling the advantages of frost-free refrigerators might be an appropriate example. Urging people to buy larger automobiles with automatic transmissions and air conditioning may be a better example.

Ask a small group of students to examine, in a good library, several issues of popular magazines such as Life, Time, Newsweek, or National Geographic that were published five to ten years ago. What advertisements urged people to buy things that used large amounts of energy? List specific examples.

Ask the group to examine, also, several very recent issues of some of the same magazines. Do advertisements now urge people to buy things that use smaller amounts of energy? List specific examples.

Ask the group to report their findings to the class and provide leadership in a total class discussion of questions such as: Is the campaign to get people to use less energy really visible? Is it likely to succeed? Why or why not?

ERIC/SMEAC, Energy Activities for the Classroom, 1976.

EFFECT OF THE ENERGY SITUATION ON WORLD POLITICS

Grade Level 10-12

Purpose: To assess the impact of the energy crisis on international relations.

Activity:

A. Have students research areas of the world which have the largest supply of energy resources. Also have the students determine areas of the world which are the greatest users of energy. Graphs and maps would be very appropriate.

B. Have the students draw possible conclusions concerning the effect of the present energy situation on American Foreign policy. Discussion should include the Middle East, Latin America, Southeast Asia, the Soviet Union, Red China, and Europe.

C. Have the students consider the energy situation in terms of international trade, including the following:

1. The difference between revenue and protective tariffs.
2. The possible consequences of protective tariffs upon the financial prosperity of the world.
3. An understanding of the European Common Market. Consider the value of such an institution on a world wide basis concerning present day energy, natural resources, and food supplies.

D. Students should consider the possible effects of the present energy situation upon the next half century.

1. How will countries alter their standard of living? (This is especially important to the U.S. and Japan.)
2. Will the countries of the world be drawn closer together or will tensions cause poorer relations?
3. Will the "under developed" nations of the world assume a role of shared leadership?

E. Students should discuss the effect of energy upon world economy and how this affects international relations.

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

ENERGY/VALUE SYSTEM

Grade Level 6-12

Purpose: To show how the energy problem involves values.

Activity:

1. List ways in which per capita energy consumption can be reduced without decreasing the quality of life. In what ways can quality of life be improved by reduced energy consumption?

2. As tie-in with the above question, estimate the minimum amount of energy you would need for bare existence.

3. As you are probably aware, many other nations are envious of America's availability of natural resources. Some of these same countries are angered by the fact that the U.S., with only 6 percent of the global population, consumes approximately 35 percent of the world's resources. Discuss (in class) the ethical implications of one social group using (per capita) 25 times as much of an unrenewable resource as another social group. Keep in mind that the United States is a major exporter of goods to other countries and that major amounts of energy are consumed in producing the export goods.

4. Population and natural resource use seems to be growing exponentially, like compound interest. Can this growth be continued for long in our already crowded planet? What might life be like if mankind lived in equilibrium with the rest of life and resources in the world? What would we need to change to arrive at that situation? How long do we need to make the change without undue trauma?

JUST ANOTHER ENERGY CRISIS?

Purpose: To review past situations in U.S. and world history which had problems parallelling the present situation.

Activity: Students will be able to research methods used for conservation of resources in previous critical phases of U.S. and world history, such as W.W. I, The Depression, and W.W. II.

Procedure--Topics which may be investigated are:

A. Daylight Savings Time

B. Food and Energy Conservation

C. Organization of Industries and Labor

D. Types of slogans and efforts which proved successful

E. Rationing of gasoline

F. Other topics might include types and numbers of automobiles appealing to consumers, household appliances considered necessary, sales approaches used by manufacturers and utility companies, etc.

NOTE: The total life style of the present day society may be compared to that of the 20s, 30s, 40s, and 50s as related to the consumption of energy.

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

A COMPARISON OF HEATING UNITS AND FUELS

Purpose: To enable students to understand characteristics of heating units and fuels.

Activity: A. Have the students try to find the following information about the different heating units (oil, gas, coal and electric furnaces, kerosene heaters, solar heating units, heat pumps, electric resistance units, and radiant electric units):

1. Principle of operation
2. Initial cost
3. Life expectancy of unit
4. Operating cost
5. Efficiency
6. BTU input, and
7. Range of BTU output

Also have students discuss the strong and weak points of forced air, hot water, steam, convection and radiant heating systems.

B. Formula for calculating the cost per therm (100,000 BTU) of various fuels and types of furnaces:

$$\text{Cost/Therm} = \frac{\text{100,000 BTU/Therm x cost of fuel per unit x 100}}{\text{\% furnace efficiency x BTU content of fuel unit}}$$

Example: Calculate the cost of therm of heat if you have an oil fired furnace with an efficiency of 70 percent, and the price of No. 2 oil is $.26 a gallon.

$$\text{cost of a therm} = \frac{\text{100,000 BTU/Therm x \$.26/gal. x 100}}{\text{70\% x 135,800 BTU/gal.}}$$

$$= \frac{2{,}600{,}000}{95{,}060}$$

$$= \$27.35$$

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

WILL THE BIGGEST "ENERGY HOG" PLEASE LEAVE THE PEN?

Purpose: To determine in what areas the greatest need for conservation of energy exists, and help students see where the priorities lie in energy conservation.

Activity: NOTE: Items can be listed first and students can estimate percentage--then actual percentage can be listed to see how close they came.

A. The consumed energy in the U.S. is distributed in this manner:

Industrial	41.2%
Transportation	25.2%
Residential	19.2%
Commercial	14.4%

In which area is the most energy consumed? Why does the burden of conservation seem to fall on the average citizen in the residential area? Could industrial use be cut in half? What effects would this have?

B. Now look at the breakdown of these areas to see where the greatest savings may occur.

Industrial	
Process steam	40.5%
Direct heat	27.7%
Others	31.8%

Would it be easy to cut the industrial energy use? What effects would this have? What inducements could be given to industries who come up with energy saving ideas and methods? Why are industries, themselves, eager to cut back on their consumption of energy?

C. Transportation

Urban passenger transportation	34.5%
Intercity passenger transportation	26.1%
Intercity freight transportation	14.5%
Other	24.9%

In which areas do you and your family consume most of your gasoline? In which area should the major emphasis on conservation be placed? What are some ways in which energy could be conserved in each area? Compare the energy consumed by shipping freight by truck, rail and air. What are some other factors involved besides cost in choosing the method for shipping freight?

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

D. Residential--energy consumed nationwide in the home is broken down as follows:

Space heat	57.3%
Water heating	15.1%
Refrigeration	5.7%
Cooking	5.7%
Air Conditioning	3.7%
Other	12.5%

In which areas are the greatest savings possible? What are some ways of saving energy in those areas?

E. Commercial--energy is consumed commercially in the following manner:

Space heating	4.8%
Air Conditioning	12.5%
Refrigeration	7.6%
Water Heating	7.6%
Other	67.5%

How would you suggest that commercial and business establishments can best conserve energy? Is it reasonable to expect home owners to cut back on their thermostats, but not businesses? How could business be induced to cut back on heating costs? Commercial heating is for you, the consumer. How could you influence businesses to cut back on thermostat and air conditioning? Do you prefer shopping at an air conditioned store in the summer?

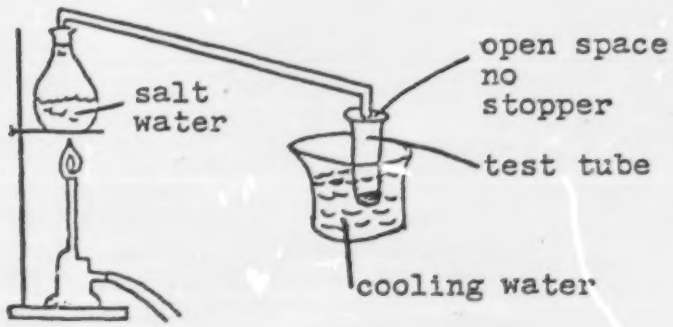
DISTILLATION OF PETROLEUM WILL PRODUCE SEVERAL PRODUCTS

Purpose: To promote an understanding of petroleum and its distilled products.

Materials: Ring stand with ring; source of heat (burner or hot plate); flask; glass tubing; 1-hole stopper; beaker; salt water; test tube; boiling chips. (Extra activity: 2-hole stopper; methanol; thermometer.)

Activity: Demonstrate the distillation of salt water by separating the salt and the water. Then discuss the distillation of crude oil to produce the products of petroleum.

EXAMPLE:



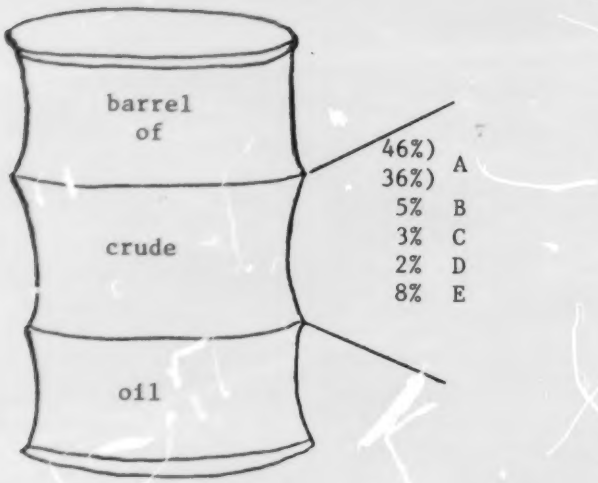
Extra Activity: Fractionally distill a solution of methanol (or duplicating fluid) and water. Use a 2-hole stopper with a thermometer inserted into the flask, record the temperature every 30 seconds. This data may be graphed to reinforce the concept of heat of vaporization.

CAUTION: Be very careful to avoid fires.

Energy Activities for the Classroom, West Virginia Department of Education, 1975.

SCIENCE INFORMATION
FRACTIONAL DISTILLATION
OF CRUDE OIL

A.	700° F. heavy gas oil	waxes asphalts heavy fuel oils
B.	510° F. gas oil	diesel oil furnace oil
C.	340° F. light gas oil	light furnace oil
D.	235° F. naphtha	gasoline
E.	215° F. gases	liquified petroleum gas



ENERGY AROUND THE WORLD

Purpose: To study how different countries use and conserve energy.

Activity:

1. Divide class into four or five groups. Assign each group a country to investigate. The groups will find out how that country uses energy. Conclusions can be presented to the class as:

   A. Reports
   B. Poster and/or map displays
   C. Constructed models
   D. Student-made slides
   E. Role playing
   F. Group organized debates

2. Instructor may want to make this a research project for one individual or a group.

3. Possible bulletin board by region.

4. Identify unique methods of using or conserving energy. For example:

   The Netherlands uses "watkars"--cars which run on batteries and do not use gasoline.

REFINERY VISIT

Purpose: To better understand the complexity and volume in the study of energy production and consumption.

Activity: Take a trip to a refinery with students.

After trip have a discussion on what has been learned.

NOTE: If refinery will allow--have students take cameras.

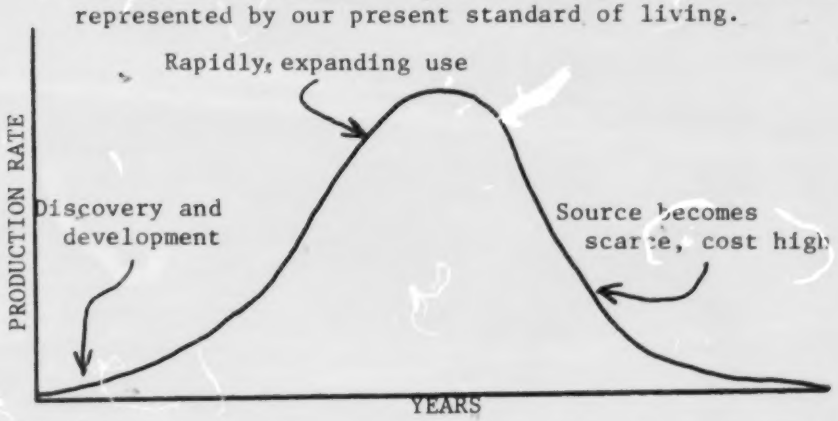
ALSO: If the refinery has handouts that they would be willing to give to the students--these can be used for class discussion.

NATURAL RESOURCE SUPPLY AND UTILIZATION

Purpose: To study the world's supply of depletable natural resources.

Concept: The production and distribution of energy have environmental and economic consequences.

Activity: Energy is that quality that allows or causes change, force, work, movement, or heat. The results of energy can be measured and its effects felt. Many people falsely assume that energy will be available forever. The world's supply of natural resources, especially those which go into the creation of energy, are not limitless. Energy producing resources are being used at an ever increasing rate by the affluent nations of the world. Until recently, very little thought or attention has been given to what will happen when the raw materials needed to produce energy become scarce and ultimately depleted. The United States has only a small fraction of the earth's population, but consumes more than one-third of the earth's annual output of natural resources to produce the goods and services represented by our present standard of living.



Answer and discuss the following questions:

1. When did the discovery of the use of oil for producing energy occur?

2. What is happening today in regard to the use of oil as an energy producing source?

3. How many years do we have left before our natural resources are depleted?

4. From the available literature obtain data adequate to construct a graph showing the life span of energy producing natural resources, such as natural gas, oil, uranium, or coal.

SIMULATION GAME

"THE ENERGY-ENVIRONMENT GAME"*

Purpose: To focus the problem of our need for energy and our need for the environment. What can we do? What should we do? Is it too late for both energy and environment?

Activity: Involve students in playing the simulation game "The Energy-Environment Game."

End Game (Allow about 15 minutes at the end of the hour.)

Discuss with students:

1. What did they learn from this game?
2. How valuable was this experience to you?
3. Is there anything that you feel should be changed?
4. Any other comments you might like to make?

*Available for purchase from:

Edison Electric Institute
90 Park Avenue
New York, New York 10016

George Zech, Teacher, Duncan, Oklahoma.

PRIORITIES FOR ENERGY USAGE

Purpose: To develop and apply criteria for allocating limited energy supplies.

Concept: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

Activity: It is quite conceivable in the years ahead that a local community might find its energy supply (gas, gasoline, electricity) curtailed significantly. Under these circumstances which energy consumers should be given the highest priority?

Divide the class into groups of three or four students. Ask each group to develop criteria they deem appropriate to apply in making priority decisions for energy usage.

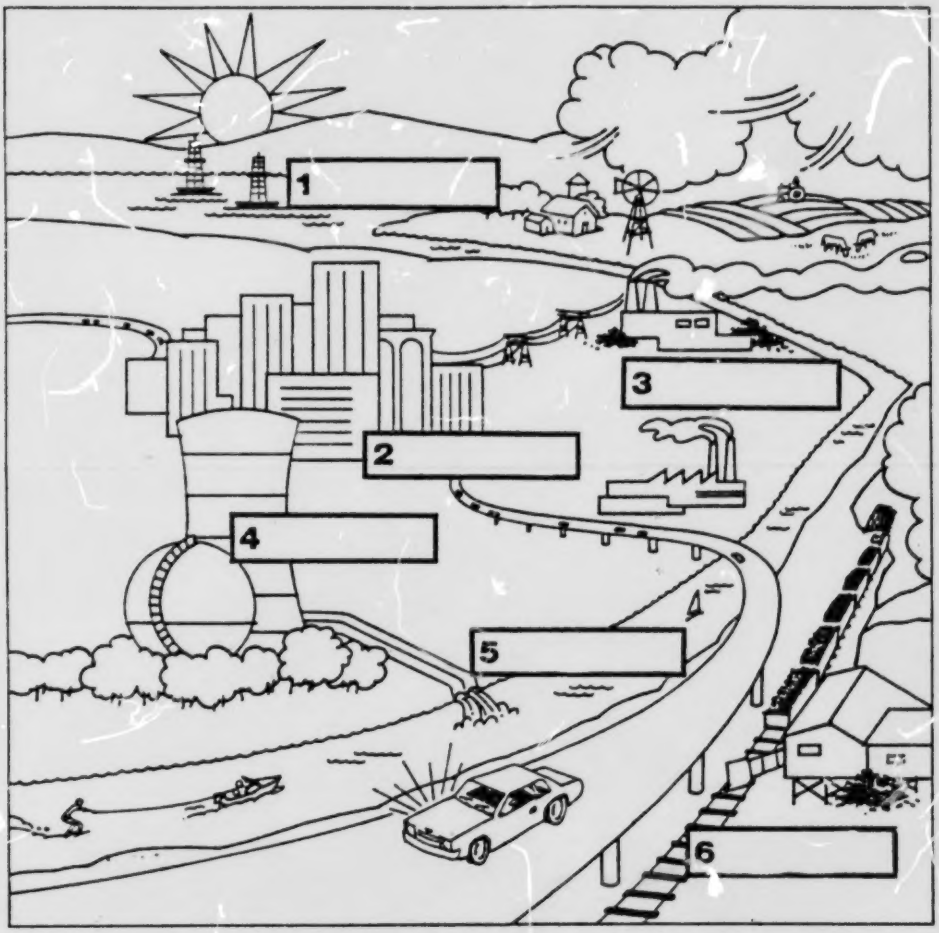
Ask each group, also, to identify major and/or critical energy users in the local community such as homes, schools, industries, hospitals, power plants, police, firemen, water systems, etc.

Finally, ask each group to apply their criteria to their identified energy users and designate priorities. Determine concensus and areas of disagreement as each group reports to the class.

What options other than the possibility of arbitrary priority allocations are available to the American people?

The Energy Book, South Carolina Department of Education, Columbia, South Carolina.

A Delicate Balance (PART 1)



1. Name the possible sources for energy in the picture. _____

2. What energy sources shown are used to generate electricity? _____

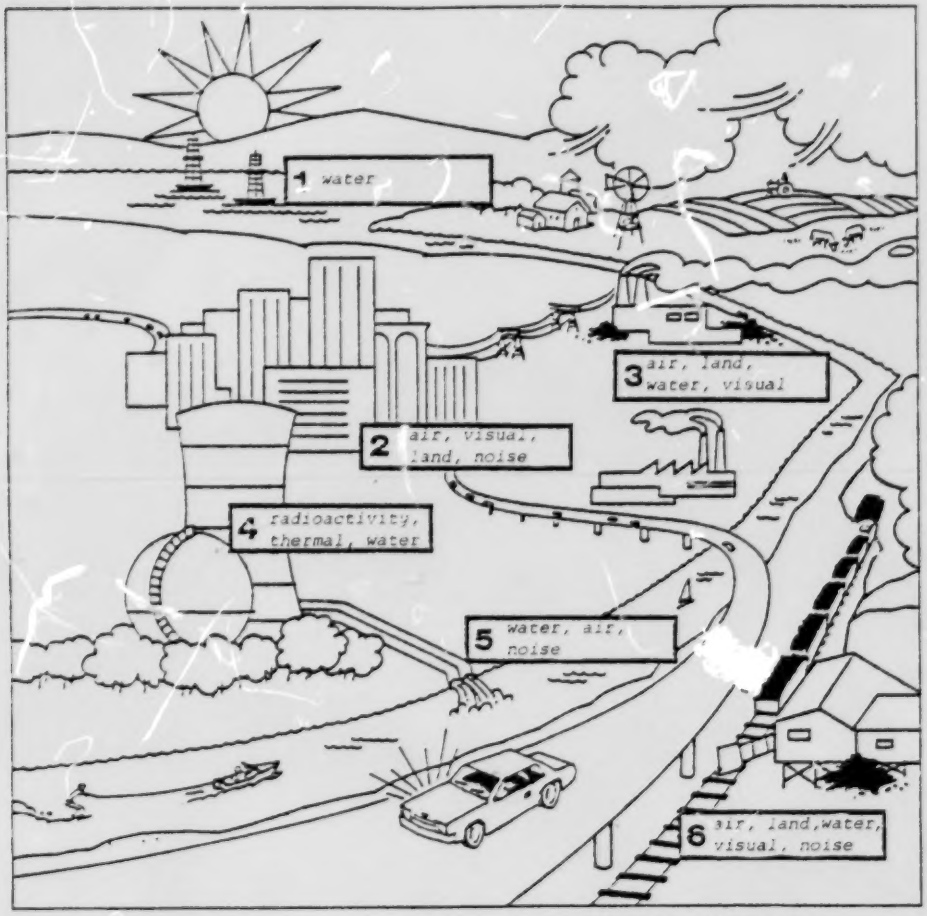
3. Seven types of environmental pollution concern us today: air, water, thermal (heat), radioactivity, visual, noise, and land disruption. In the boxes on the picture above, write in the type of possible pollution occurring in that part of the picture.

4. How do different parts of your environment—air, water, land, people, city, country—affect each other?

5. To help keep that delicate balance between meeting our energy needs and maintaining a clean and healthy environment, what in your life would you be willing to change?

The Energy Cnallenge, Federal Energy Administration, Washington, D.C.

A Delicate Balance (PART 1)


1 water
2 air, visual, land, noise
3 air, land, water, visual
4 radioactivity, thermal, water
5 water, air, noise
6 air, land, water, visual, noise

1. Name the possible sources for energy in the picture. sun, wind, coal, oil, nuclear reaction

2. What energy sources shown are used to generate electricity? coal, nuclear reaction

3. Seven types of environmental pollution concern us today: air, water, thermal (heat), radioactivity, visual, noise, and land disruption. In the boxes on the picture above, write in the type of possible pollution occurring in that part of the picture.

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The Energy Challenge, Federal Energy Administration, Washington, D.C.

A Delicate Balance

(Part 2)

From the clues given on the chart below, identify each type of pollution: water, air, or land disruption. In the last column of the chart, place the number of the choice listed here that you agree with.

1. "I know I will have to spend more dollars to pay for electricity, fuel, gasoline, and other energy-related products so that energy producers can pay for environmental controls."
2. "I will cut back on my own energy use — really practice conservation."
3. "I will support more government regulations."
4. "I can count on business and industry to find the answers."
5. "I'm willing to live with pollution."
6. If you can think of other solutions, write them down.

TYPE OF POLLUTION	WHAT IS IT?	WHAT CAN IT DO?	HOW CAN IT BE IMPROVED?	WHAT WOULD I BE WILLING TO DO?
	It is the adverse effect from burning coal and oil, and from car exhausts. It is high concentrations of carbon monoxide, sulfur dioxide, and unburned ash.	It can increase respiratory illnesses and raise death rates. It can damage crops, plants, and trees.	By installing emission controls on autos and filters or traps on chimneys. By cutting down on the burning of coal and oil. By burning solid wastes in closed incinerators. By capturing and reusing industrial gases for other products.	
	It is the use of millions of acres for mining, development of power plants, refineries, transmission lines, energy-resource storage, and solid waste disposal.	It can disturb wilderness and recreation areas. It can destroy vital plant-animal food chains and can cause erosion and loss of soil nutrients.	By reclaiming mine sites. By landfilling and recycling solid wastes. By replanting vegetation, reforesting, building lakes and recreational parks.	
	It is high amounts of impurities such as disease-causing organic wastes, toxic substances such as acids and pesticides. It can be caused by oil spillage, offshore construction, industrial waste, and municipal sewage.	It can disturb or destroy fish breeding and feeding grounds, can cause taste and odor problems, clog streams, destroy recreation areas and sometimes cause disease in humans. Mines can contaminate ground water.	By installing filters, aeration and settling devices. By breaking down impurities with chemicals. By cleaning up rivers and shorelines. By transforming acid wastes to useful by-products.	

THINK ABOUT IT: Make a list of things you can do today to help stop pollution.
Start with these: Don't litter. Recycle. Use public transportation. Don't burn rubbish or leaves. Can you add to the list?

The Energy Challenge, Federal Energy Administration, Washington, D.C.

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The Energy Challenge, Federal Energy Administration, Washington, D.C.

Supply and Demand; Shortage and Surplus

Finish the story by filling in the blanks. Think of the right answer. Then see if it appears in the answers below. Put its number in the blank. Some answers may be used more than once.

POSSIBLE ANSWERS

1. 40
2. lowered
3. supply
4. 200 gallons
5. $3.00
6. 5 gallons
7. shortage
8. raised
9. surplus
10. 160 gallons
11. demand
12. $60.00

Mr. Smith, a gasoline station owner, received 200 gallons of gasoline regularly each week. His 20 regular Smalltown customers were used to buying all the gas they needed. Although some weeks some people bought more and some bought less, average use was 10 gallons a week. The total demand for gasoline each week, then, was _____. As you have seen, Mr. Smith's supply was _____. Everybody was pretty happy about the whole thing, since supply was equal to the _____.

Mr. Smith charged 30¢ a gallon for gasoline, a price that was about the same as that charged by the other station in town. Each regular customer spent an average of _____ each week. Mr. Smith received _____ for gasoline. When the other station reduced its price per gallon by a penny, four of Mr. Smith's regular customers deserted him and went across the street. He was still getting a delivery of 200 gallons a week, but now the demand was only _____. He had _____ gallons left over. This unbought quantity of gasoline is called a _____. To get rid of the surplus, Mr. Smith _____ his price. His other regular customers bought up the _____ and took a few more pleasure trips into the city.

Several weeks later, Mr. Smith and the other station each received only 100 gallons of gasoline. Their suppliers were short of gasoline that week. Their customers' demands were still the same, so the pumps soon became empty. "No More Gas!" the sign in front said. Halfway through the week, Mr. Smith had a _____ of gasoline. By still charging 30¢ a gallon, he didn't make enough to pay the costs of his station.

The next week he raised the price to 60¢ a gallon. Even at the higher price, most of his customers still had to buy gas to drive to work and do errands, so he sold all 100 gallons. How much money did he receive? _____ What was the average amount each of the 20 regular customers spent? _____. What was the average amount of gas each customer used? _____

Some of Mr. Smith's customers were on a fixed budget and couldn't afford to spend more than $3 a week for gas. Some customers got to the station after the pumps were empty and couldn't get all they needed. Some of the other station's customers came over to Mr. Smith's station. The demand was greater than the _____. Mr. Smith _____ his gasoline prices again.

Discuss in your class ways in which the people of Smalltown might solve their gasoline supply problem.

The Energy Challenge, Federal Energy Administration, Washington, D.C.

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Mr. Smith charged 30¢ a gallon for gasoline, a price that was about the same as that charged by the other station in town. Each regular customer spent an average of ___5___ each week. Mr. Smith received ___12___ for gasoline. When the other station reduced its price per gallon by a penny, four of Mr. Smith's regular customers deserted him and went across the street. He was still getting a delivery of 200 gallons a week, but now the demand was only ___10___. He had ___1___ gallons left over. This unbought quantity of gasoline is called a ___9___. To get rid of the surplus, Mr. Smith ___2___ his price. His other regular customers bought up the ___9___ and took a few more pleasure trips into the city.

Several weeks later, Mr. Smith and the other station each received only 100 gallons of gasoline. Their suppliers were short of gasoline that week. Their customers' demands were still the same, so the pumps soon became empty. "No More Gas!" the sign in front said. Halfway through the week, Mr. Smith had a ___7___ of gasoline. By still charging 30¢ a gallon, he didn't make enough to pay the costs of his station.

The next week he raised the price to 60¢ a gallon. Even at the higher price, most of his customers still had to buy gas to drive to work and do errands, so he sold all 100 gallons. How much money did he receive? ___12___. What was the average amount each of the 20 regular customers spent? ___5___. What was the average amount of gas each customer used? ___6___.

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The Energy Challenge, Federal Energy Administration, Washington, D.C.